US011636163B2

(12) **United States Patent**
Pennell et al.

(10) **Patent No.: US 11,636,163 B2**
(45) **Date of Patent: *Apr. 25, 2023**

(54) **TECHNIQUES FOR ANONYMIZED SEARCHING OF MEDICAL PROVIDERS**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Mark E. Pennell**, Redwood City, CA (US); **Jorge F. Pozas Trevino**, San Mateo, CA (US); **Sean R. Moore**, San Francisco, CA (US); **Sami Shaio**, New York, NY (US); **Sangeeth Sridharan**, San Jose, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 291 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/001,128**

(22) Filed: **Aug. 24, 2020**

(65) **Prior Publication Data**

US 2020/0387555 A1 Dec. 10, 2020

Related U.S. Application Data

(63) Continuation of application No. 15/947,478, filed on Apr. 6, 2018, now Pat. No. 10,824,684.
(Continued)

(51) **Int. Cl.**
G06F 16/951 (2019.01)
G16H 40/20 (2018.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G06F 16/951*** (2019.01); ***G06F 16/29*** (2019.01); ***G06F 21/6254*** (2013.01); ***G16H 10/60*** (2018.01); ***G16H 40/20*** (2018.01)

(58) **Field of Classification Search**
CPC G06F 16/29; G06F 16/951; G06F 21/6227; G06F 21/6254; G06F 2221/2111; G16H 40/20; G16H 10/60
See application file for complete search history.

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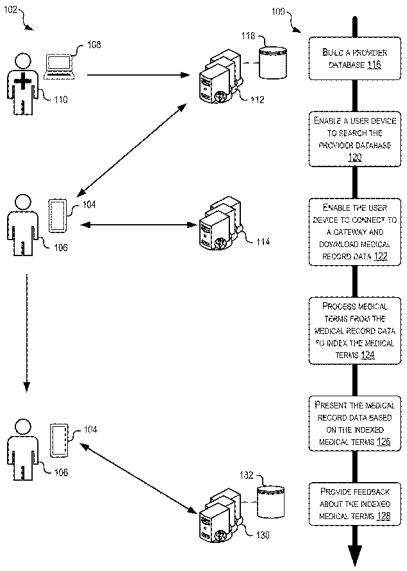
Primary Examiner — Etienne P Leroux
(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton

(57) **ABSTRACT**

A server may maintain information about entities such as medical entities. A user device can send search queries to the server to obtain information about a particular medical entity. The server and/or the user device may maintain information relating to the particular medical entity in a manner that a relationship between the particular medical entity and the user device can be obfuscated from the server. By doing so, privacy of a user of the user device can be protected.

20 Claims, 47 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 62/566,051, filed on Sep. 29, 2017.

(51) **Int. Cl.**

G16H 10/60	(2018.01)
G06F 16/29	(2019.01)
G06F 21/62	(2013.01)

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2006/0080246	A1	4/2006	Cook et al.	
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2007/0185732	A1	8/2007	Hicks et al.	
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2008/0249386	A1	10/2008	Besterman et al.	
2008/0256329	A1	10/2008	Heinze et al.	
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2009/0070140	A1	3/2009	Morsch et al.	
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2009/0276369	A1	11/2009	Gorman et al.	
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2016/0224542	A1	8/2016	Bulgakov et al.	
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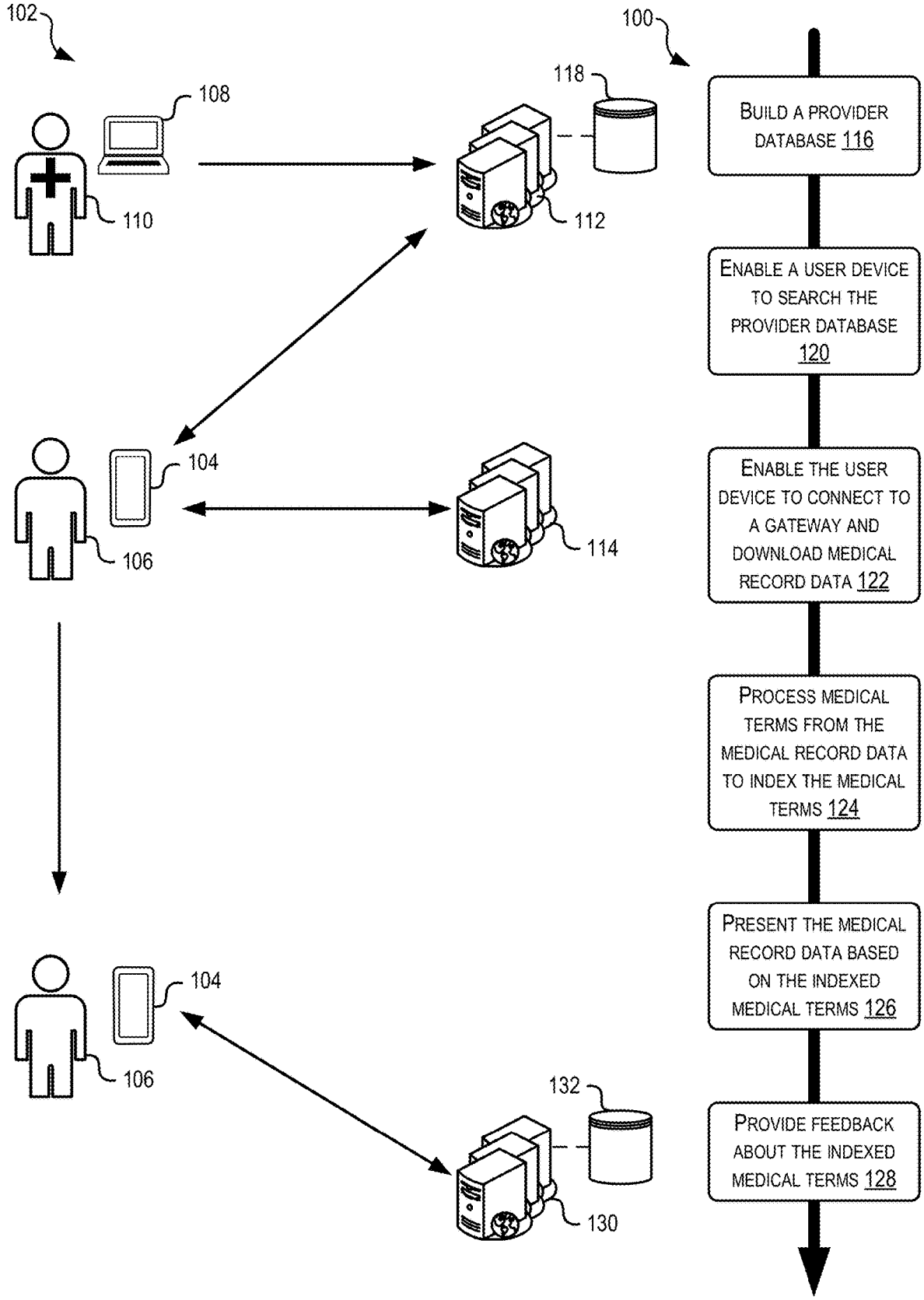

102
100
108
118
110
112
BUILD A PROVIDER DATABASE 116
ENABLE A USER DEVICE TO SEARCH THE PROVIDER DATABASE 120
104
ENABLE THE USER DEVICE TO CONNECT TO A GATEWAY AND DOWNLOAD MEDICAL RECORD DATA 122
106
114
PROCESS MEDICAL TERMS FROM THE MEDICAL RECORD DATA TO INDEX THE MEDICAL TERMS 124
PRESENT THE MEDICAL RECORD DATA BASED ON THE INDEXED MEDICAL TERMS 126
104
106
132
PROVIDE FEEDBACK ABOUT THE INDEXED MEDICAL TERMS 128
130

FIG. 1

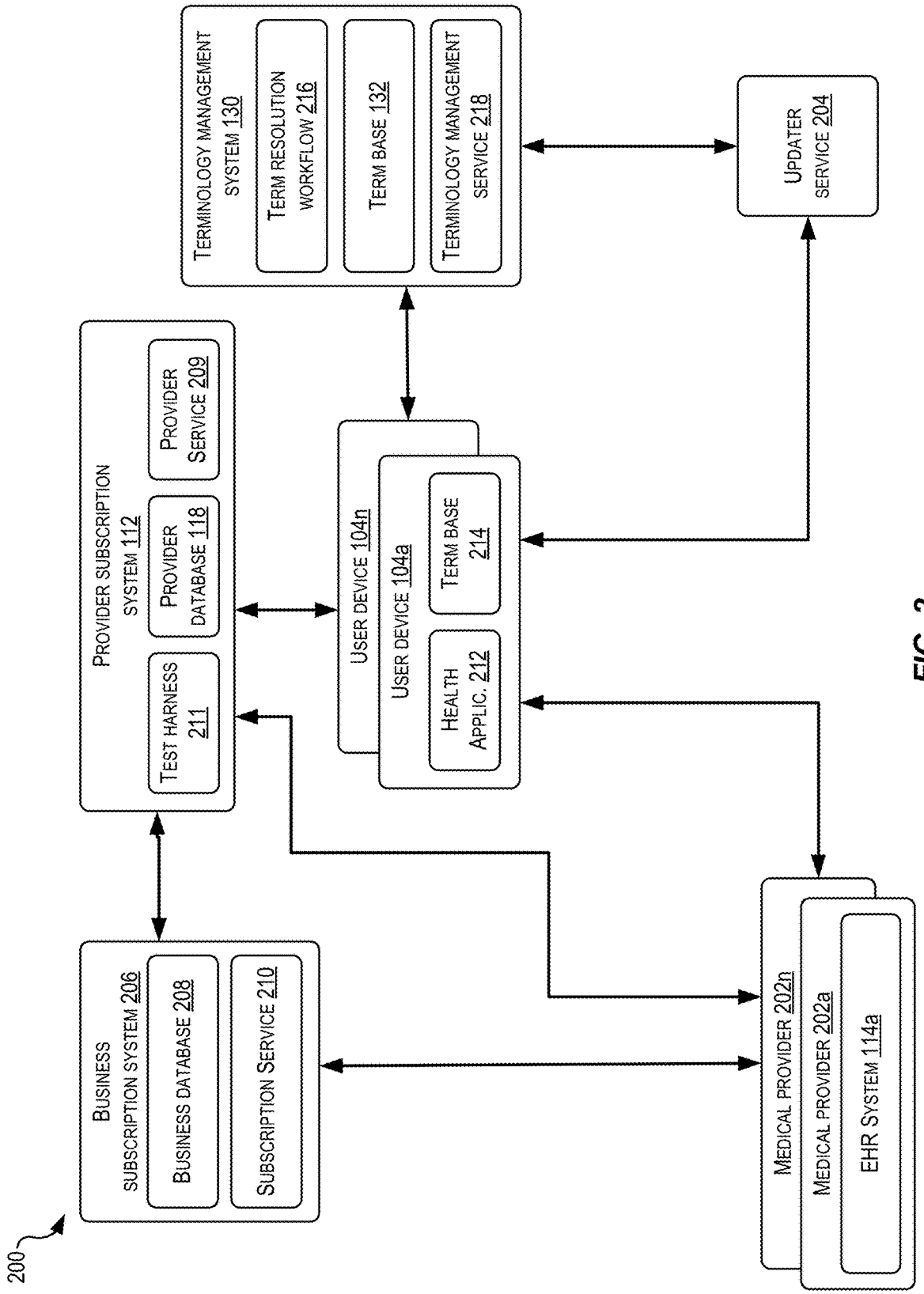

200
BUSINESS SUBSCRIPTION SYSTEM 206
BUSINESS DATABASE 208
SUBSCRIPTION SERVICE 210
PROVIDER SUBSCRIPTION SYSTEM 112
TEST HARNESS 211
PROVIDER DATABASE 118
PROVIDER SERVICE 209
TERMINOLOGY MANAGEMENT SYSTEM 130
TERM RESOLUTION WORKFLOW 216
TERM BASE 132
TERMINOLOGY MANAGEMENT SERVICE 218
UPDATER SERVICE 204
USER DEVICE 104n
USER DEVICE 104a
HEALTH APPLIC. 212
TERM BASE 214
MEDICAL PROVIDER 202n
MEDICAL PROVIDER 202a
EHR SYSTEM 114a

FIG. 2

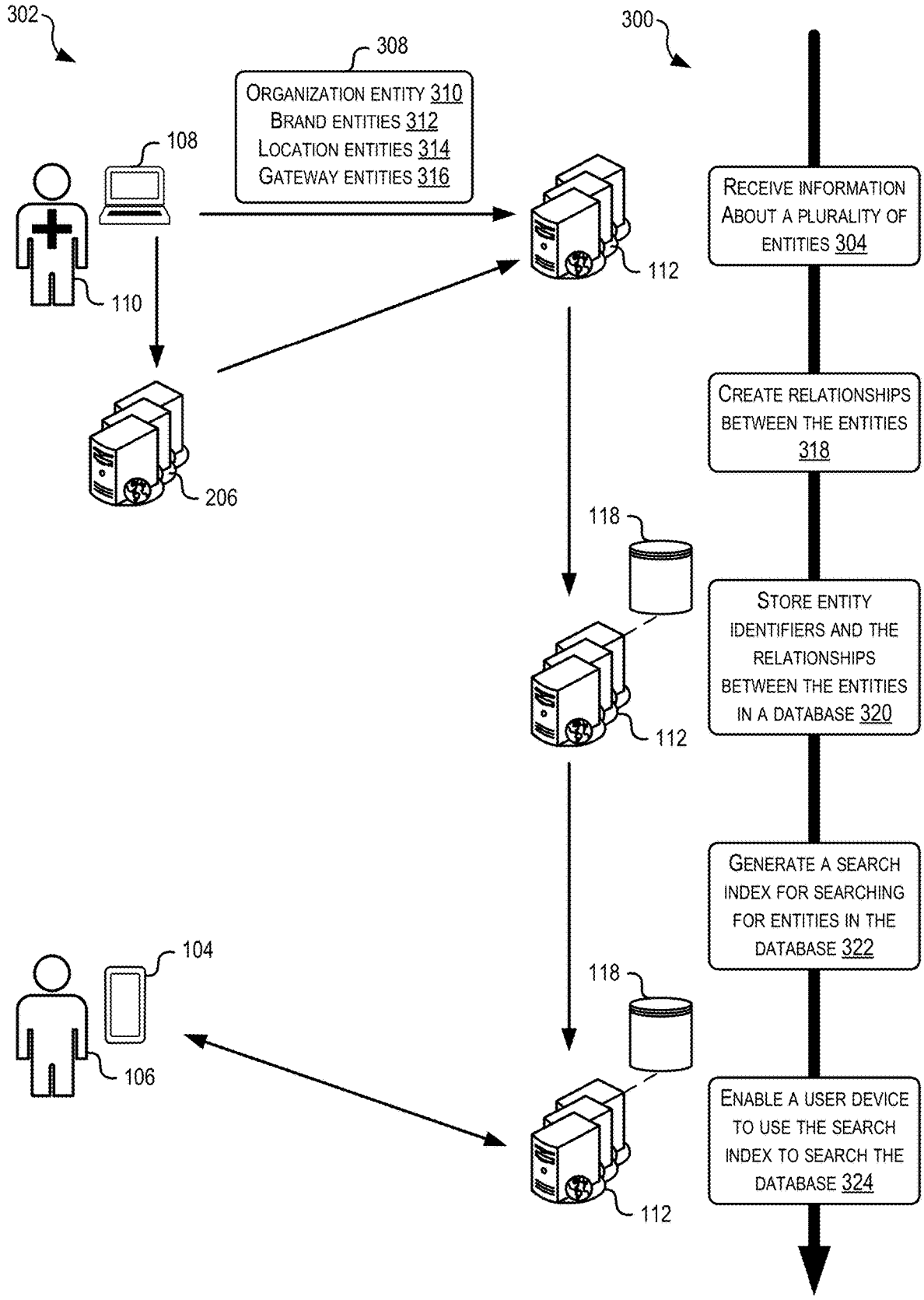
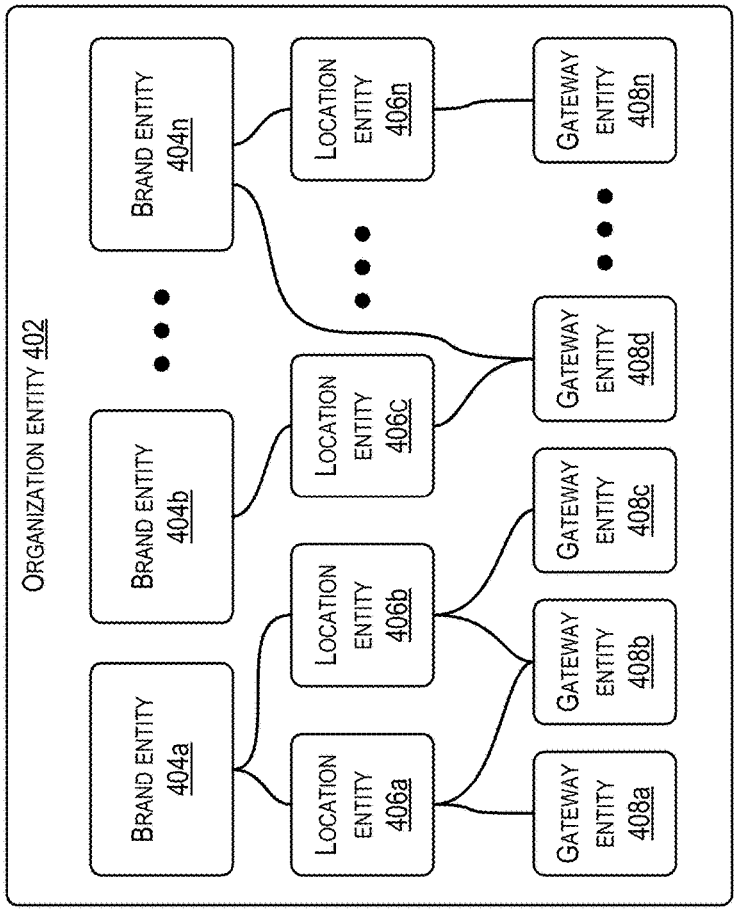

302
300
308
ORGANIZATION ENTITY 310
BRAND ENTITIES 312
LOCATION ENTITIES 314
GATEWAY ENTITIES 316
108
110
112
206
118
112
104
106
118
112
RECEIVE INFORMATION ABOUT A PLURALITY OF ENTITIES 304
CREATE RELATIONSHIPS BETWEEN THE ENTITIES 318
STORE ENTITY IDENTIFIERS AND THE RELATIONSHIPS BETWEEN THE ENTITIES IN A DATABASE 320
GENERATE A SEARCH INDEX FOR SEARCHING FOR ENTITIES IN THE DATABASE 322
ENABLE A USER DEVICE TO USE THE SEARCH INDEX TO SEARCH THE DATABASE 324

FIG. 3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BRAND ENTITY 404a
BRAND ENTITY 404b
BRAND ENTITY 404n
LOCATION ENTITY 406a
LOCATION ENTITY 406b
LOCATION ENTITY 406c
LOCATION ENTITY 406n
GATEWAY ENTITY 408a
GATEWAY ENTITY 408b
GATEWAY ENTITY 408c
GATEWAY ENTITY 408d
GATEWAY ENTITY 408n

400

FIG. 4

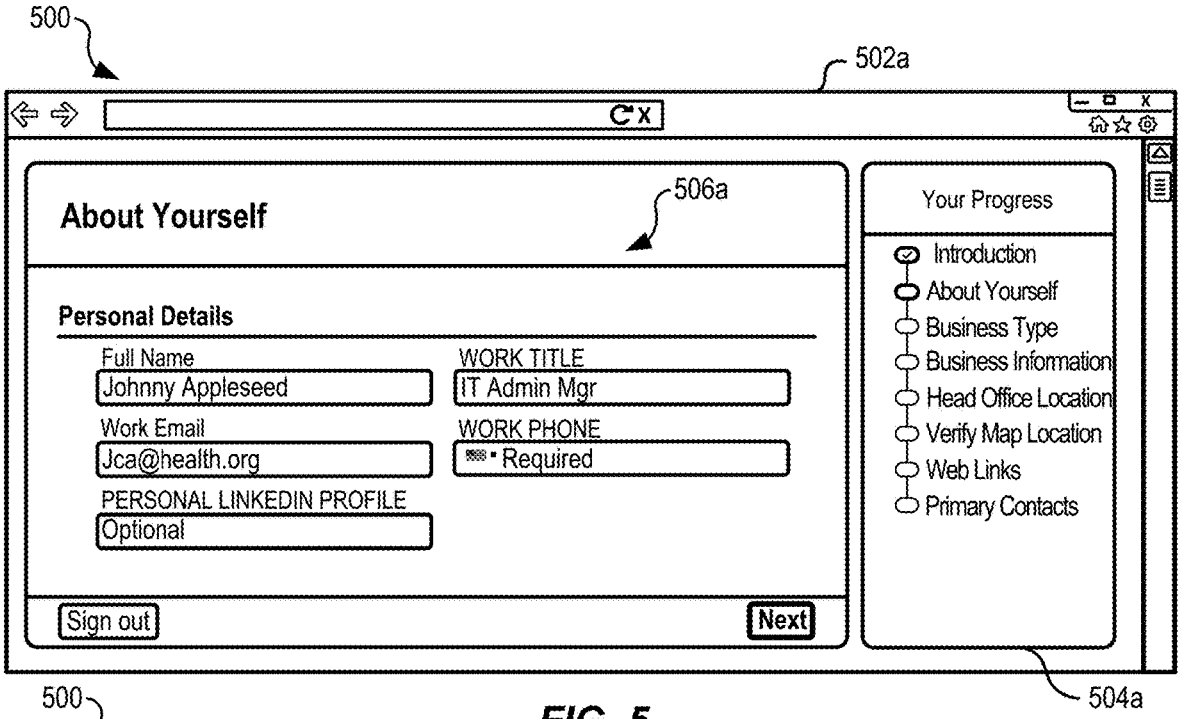

500
502a
About Yourself
506a
Personal Details
Full Name
Johnny Appleseed
WORK TITLE
IT Admin Mgr
Work Email
Jca@health.org
WORK PHONE
Required
PERSONAL LINKEDIN PROFILE
Optional
Sign out
Next
Your Progress
Introduction
About Yourself
Business Type
Business Information
Head Office Location
Verify Map Location
Web Links
Primary Contacts
504a

FIG. 5

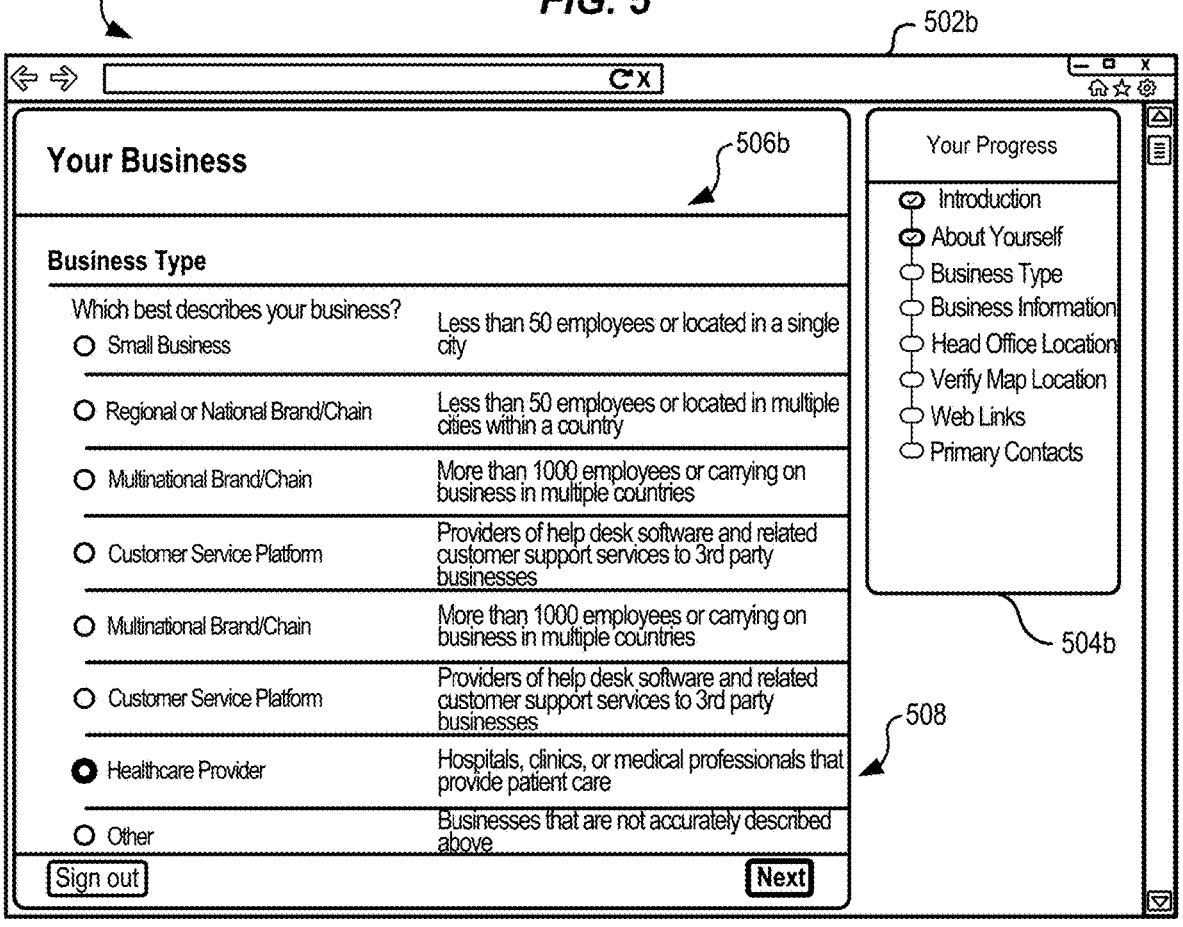

500
502b
Your Business
506b
Business Type
Which best describes your business?
Small Business
Less than 50 employees or located in a single city
Regional or National Brand/Chain
Less than 50 employees or located in multiple cities within a country
Multinational Brand/Chain
More than 1000 employees or carrying on business in multiple countries
Customer Service Platform
Providers of help desk software and related customer support services to 3rd party businesses
Multinational Brand/Chain
More than 1000 employees or carrying on business in multiple countries
Customer Service Platform
Providers of help desk software and related customer support services to 3rd party businesses
Healthcare Provider
Hospitals, clinics, or medical professionals that provide patient care
Other
Businesses that are not accurately described above
508
Sign out
Next
Your Progress
Introduction
About Yourself
Business Type
Business Information
Head Office Location
Verify Map Location
Web Links
Primary Contacts
504b

FIG. 6

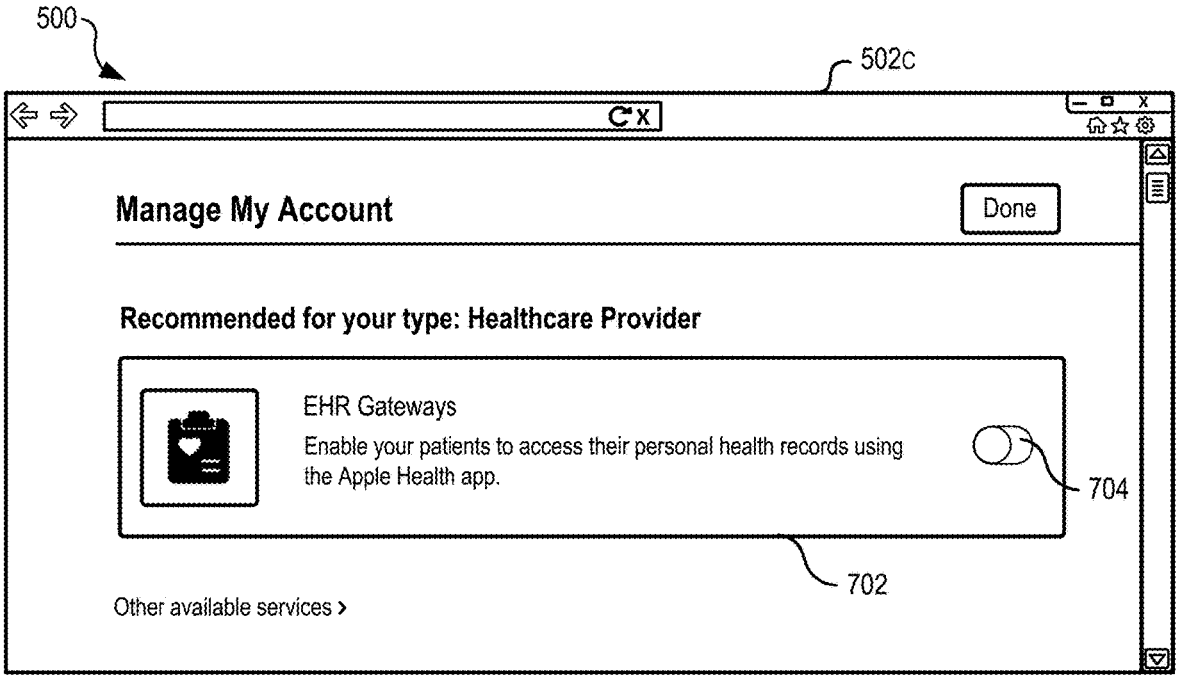

500
502c
Manage My Account
Done
Recommended for your type: Healthcare Provider
EHR Gateways
Enable your patients to access their personal health records using the Apple Health app.
704
702
Other available services ›

FIG. 7

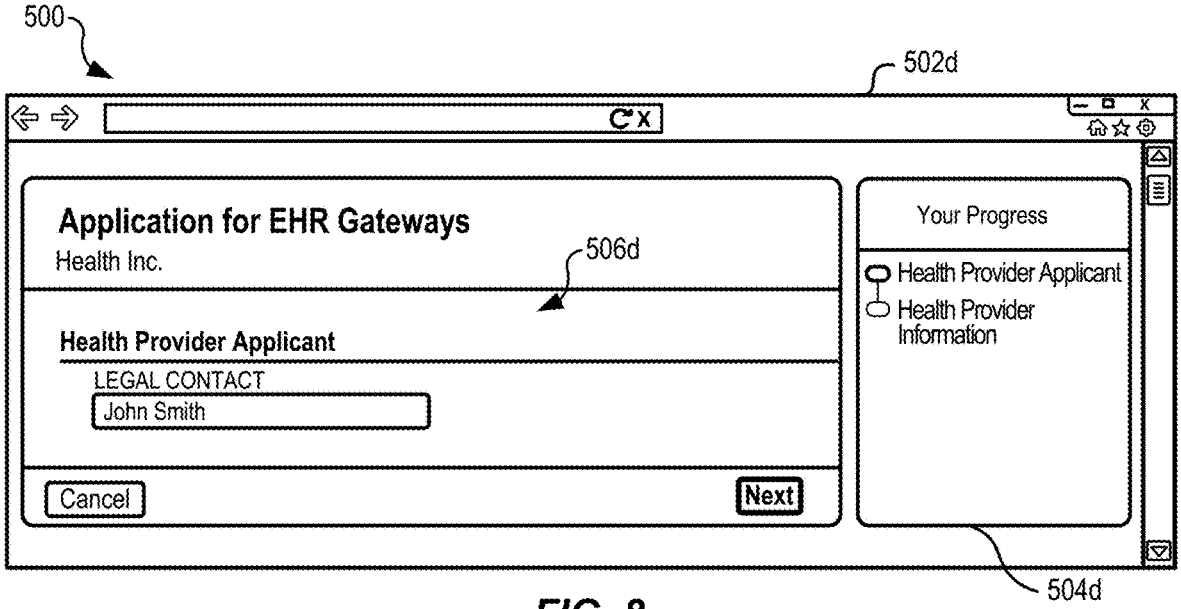

500
502d
Application for EHR Gateways
Health Inc.
506d
Health Provider Applicant
LEGAL CONTACT
John Smith
Cancel
Next
Your Progress
Health Provider Applicant
Health Provider Information
504d

FIG. 8

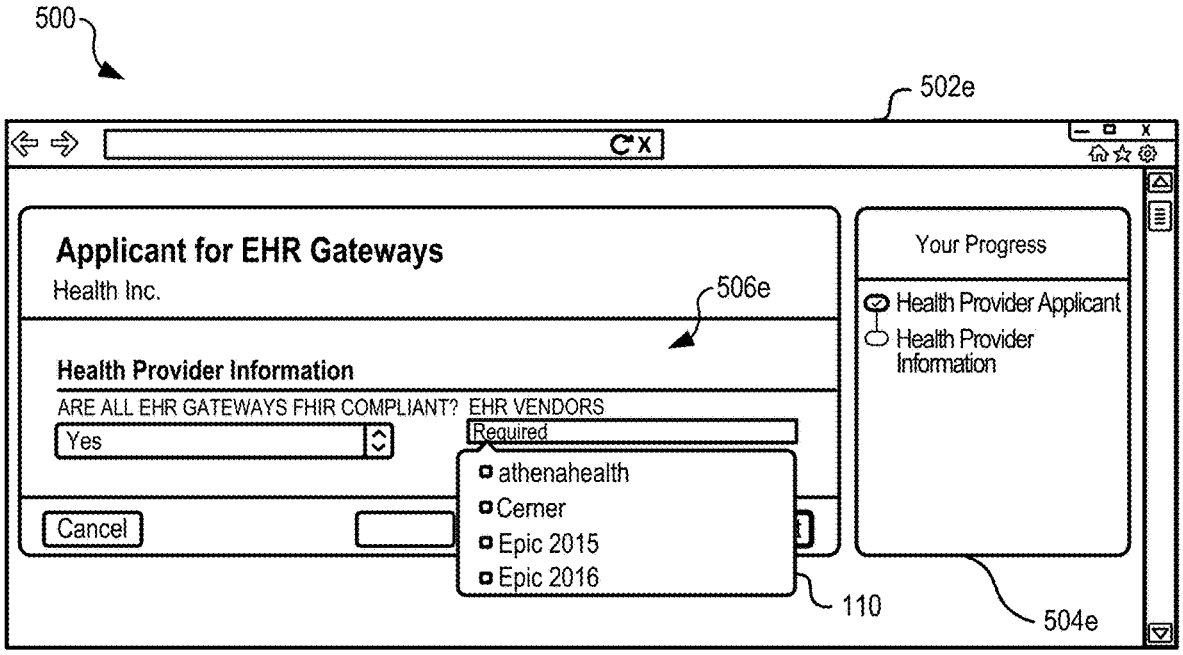

500
502e
Applicant for EHR Gateways
Health Inc.
506e
Health Provider Information
ARE ALL EHR GATEWAYS FHIR COMPLIANT?
Yes
EHR VENDORS
Required
athenahealth
Cerner
Epic 2015
Epic 2016
Cancel
110
Your Progress
Health Provider Applicant
Health Provider Information
504e

FIG. 9

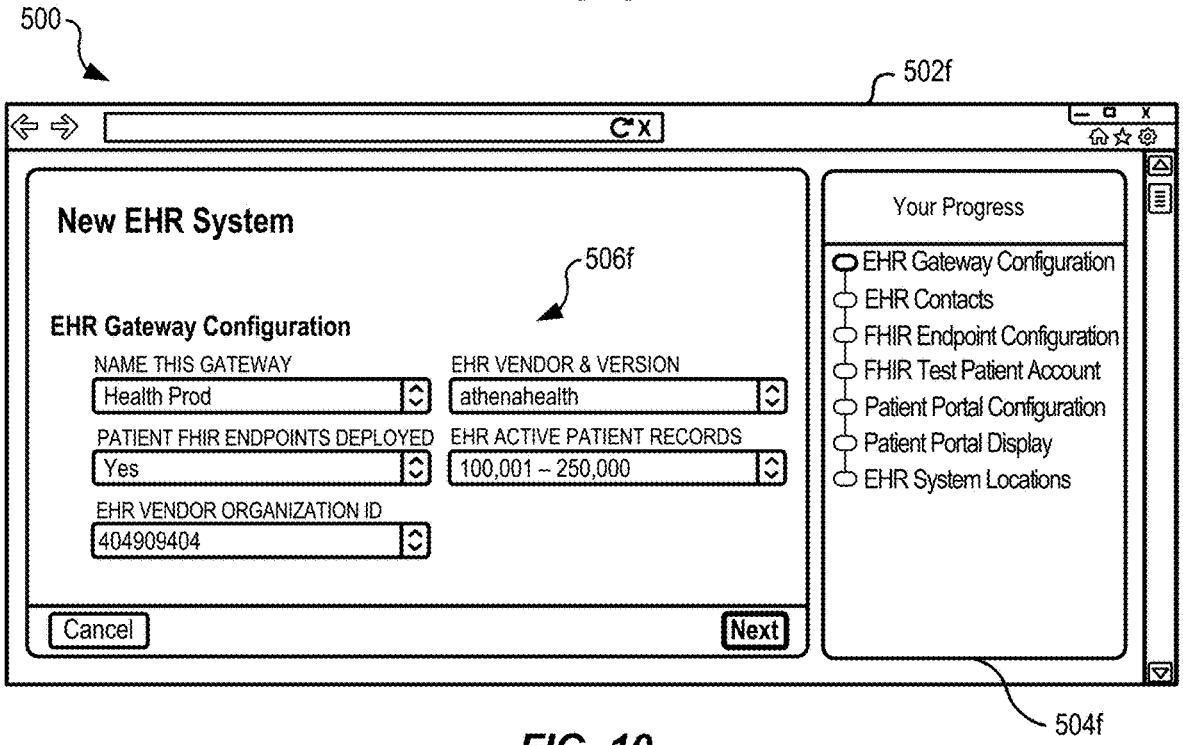

500
502f
New EHR System
506f
EHR Gateway Configuration
NAME THIS GATEWAY
Health Prod
EHR VENDOR & VERSION
athenahealth
PATIENT FHIR ENDPOINTS DEPLOYED
Yes
EHR ACTIVE PATIENT RECORDS
100,001 – 250,000
EHR VENDOR ORGANIZATION ID
404909404
Cancel
Next
Your Progress
EHR Gateway Configuration
EHR Contacts
FHIR Endpoint Configuration
FHIR Test Patient Account
Patient Portal Configuration
Patient Portal Display
EHR System Locations
504f

FIG. 10

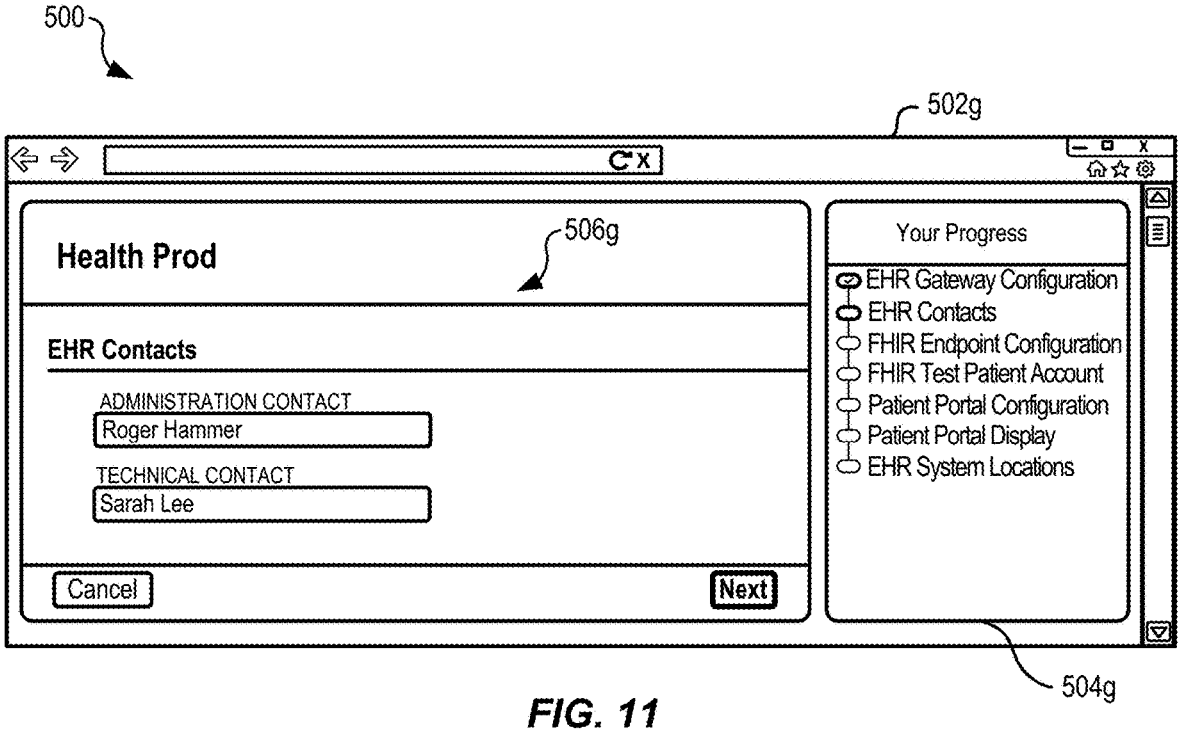
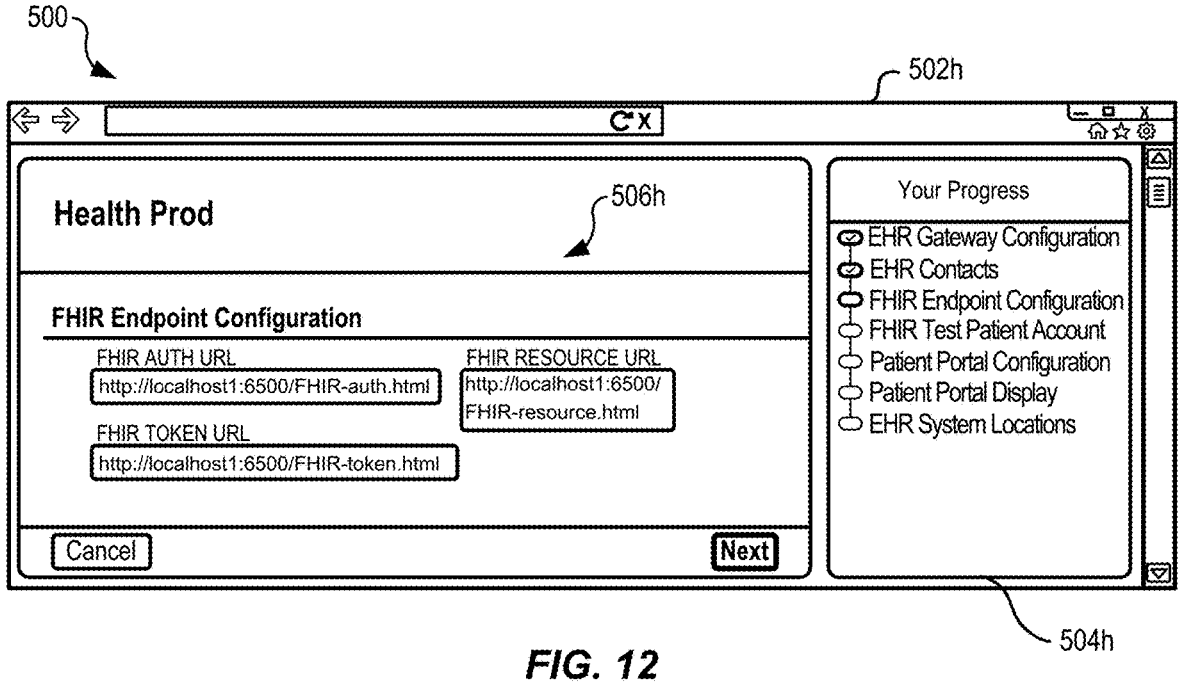

500
502g
Health Prod
506g
EHR Contacts
ADMINISTRATION CONTACT
Roger Hammer
TECHNICAL CONTACT
Sarah Lee
Cancel
Next
Your Progress
EHR Gateway Configuration
EHR Contacts
FHIR Endpoint Configuration
FHIR Test Patient Account
Patient Portal Configuration
Patient Portal Display
EHR System Locations
504g

FIG. 11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502h
Health Prod
506h
FHIR Endpoint Configuration
FHIR AUTH URL
http://localhost1:6500/FHIR-auth.html
FHIR RESOURCE URL
http://localhost1:6500/
FHIR-resource.html
FHIR TOKEN URL
http://localhost1:6500/FHIR-token.html
Cancel
Next
Your Progress
EHR Gateway Configuration
EHR Contacts
FHIR Endpoint Configuration
FHIR Test Patient Account
Patient Portal Configuration
Patient Portal Display
EHR System Locations
504h

FIG. 12

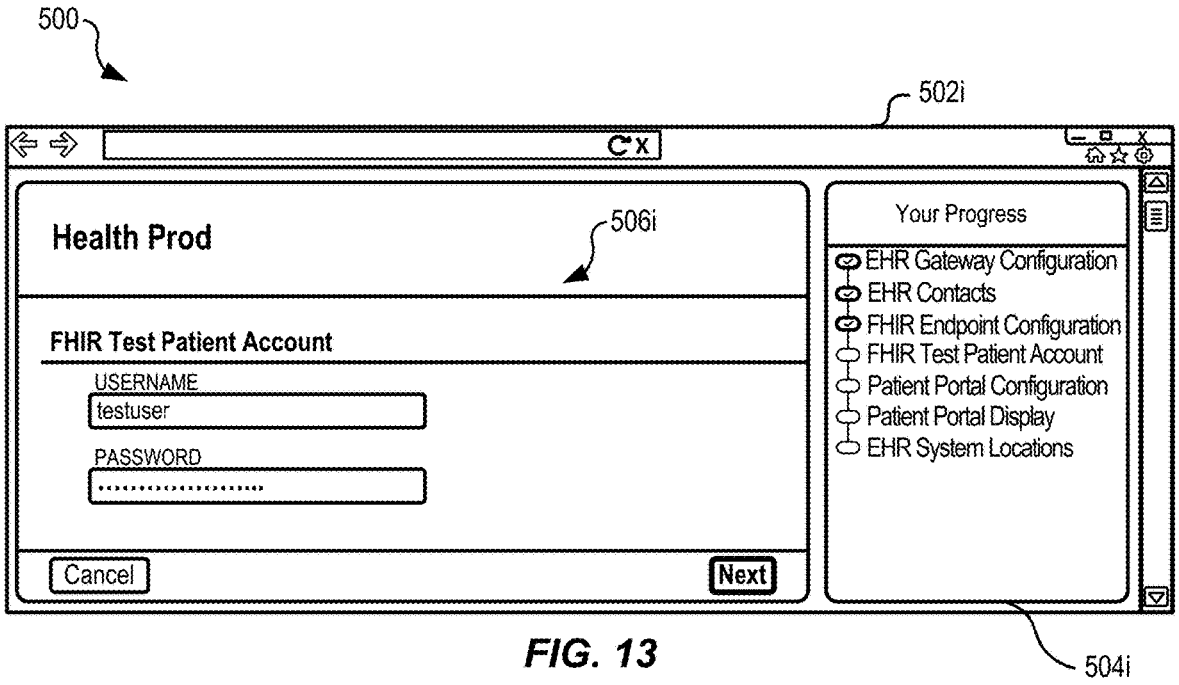
500
502i
Health Prod
506i
FHIR Test Patient Account
USERNAME
testuser
PASSWORD
Cancel
Next
Your Progress
EHR Gateway Configuration
EHR Contacts
FHIR Endpoint Configuration
FHIR Test Patient Account
Patient Portal Configuration
Patient Portal Display
EHR System Locations
504i

FIG. 13

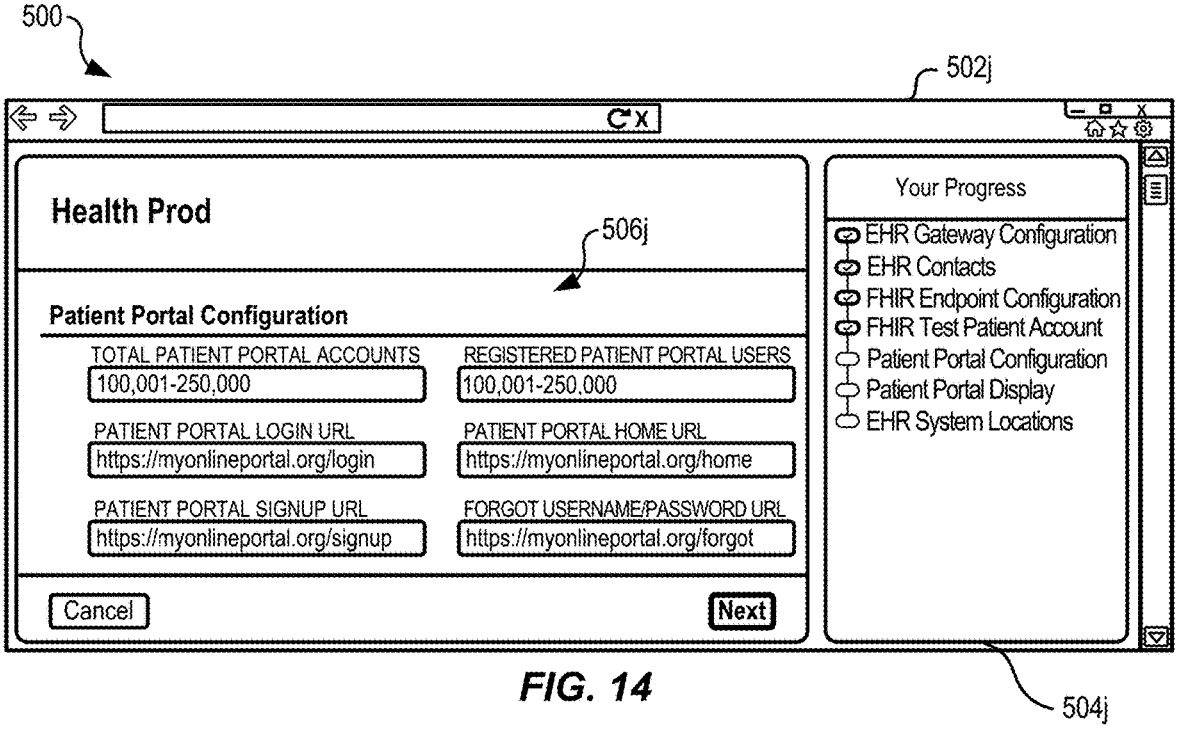
500
502j
Health Prod
506j
Patient Portal Configuration
TOTAL PATIENT PORTAL ACCOUNTS
100,001-250,000
REGISTERED PATIENT PORTAL USERS
100,001-250,000
PATIENT PORTAL LOGIN URL
https://myonlineportal.org/login
PATIENT PORTAL HOME URL
https://myonlineportal.org/home
PATIENT PORTAL SIGNUP URL
https://myonlineportal.org/signup
FORGOT USERNAME/PASSWORD URL
https://myonlineportal.org/forgot
Cancel
Next
Your Progress
EHR Gateway Configuration
EHR Contacts
FHIR Endpoint Configuration
FHIR Test Patient Account
Patient Portal Configuration
Patient Portal Display
EHR System Locations
504j

FIG. 14

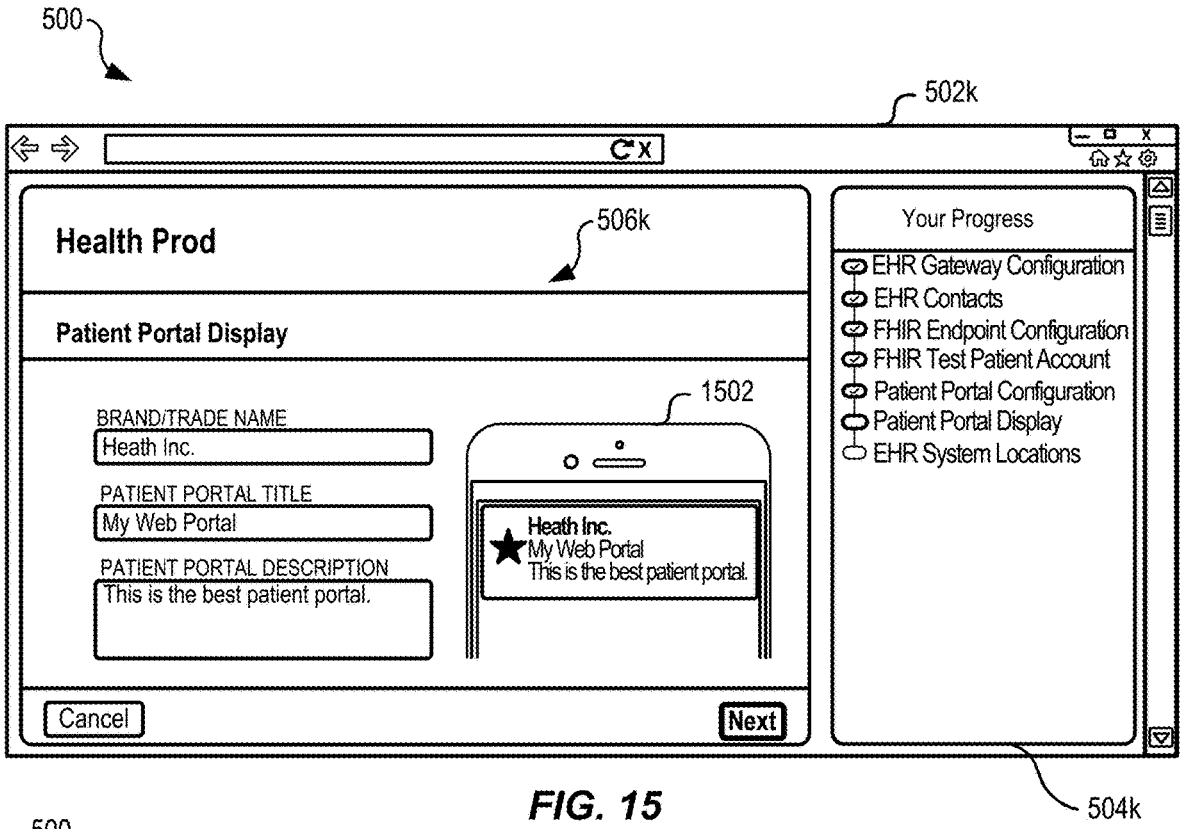
500
502k
Health Prod
506k
Patient Portal Display
BRAND/TRADE NAME
Heath Inc.
PATIENT PORTAL TITLE
My Web Portal
PATIENT PORTAL DESCRIPTION
This is the best patient portal.
1502
Heath Inc.
My Web Portal
This is the best patient portal.
Cancel
Next
Your Progress
EHR Gateway Configuration
EHR Contacts
FHIR Endpoint Configuration
FHIR Test Patient Account
Patient Portal Configuration
Patient Portal Display
EHR System Locations
504k

FIG. 15

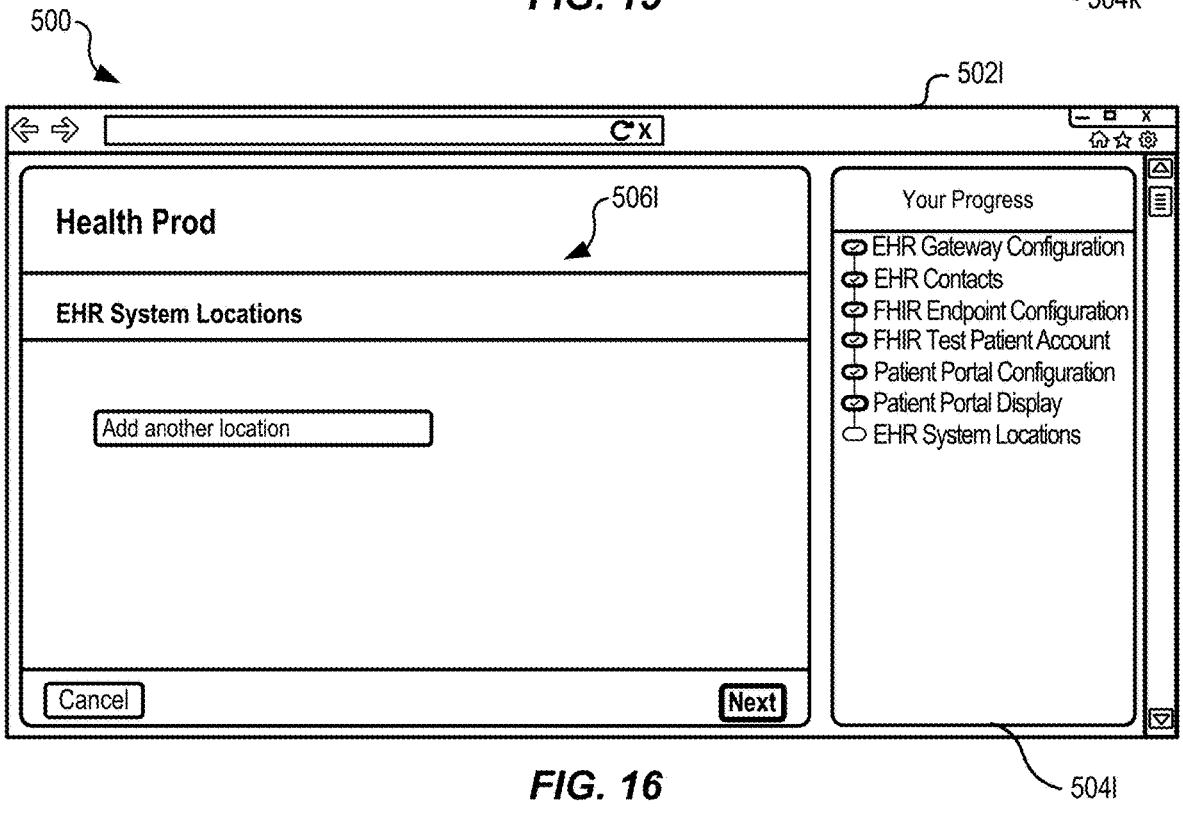
500
502l
Health Prod
506l
EHR System Locations
Add another location
Cancel
Next
Your Progress
EHR Gateway Configuration
EHR Contacts
FHIR Endpoint Configuration
FHIR Test Patient Account
Patient Portal Configuration
Patient Portal Display
EHR System Locations
504l

FIG. 16

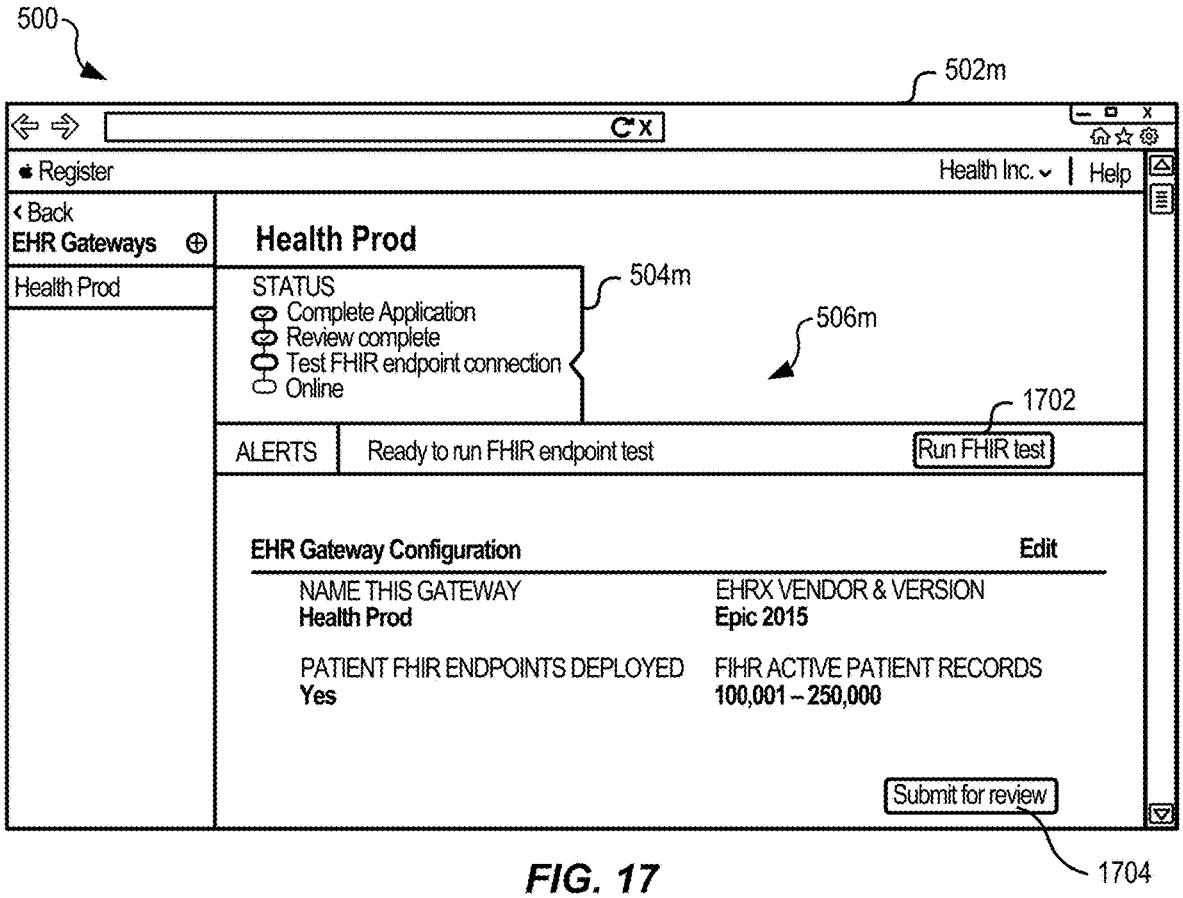
500
502m
Register
Health Inc.
Help
Back
EHR Gateways
Health Prod
Health Prod
STATUS
Complete Application
Review complete
Test FHIR endpoint connection
Online
504m
506m
1702
ALERTS
Ready to run FHIR endpoint test
Run FHIR test
EHR Gateway Configuration
Edit
NAME THIS GATEWAY
Health Prod
EHRX VENDOR & VERSION
Epic 2015
PATIENT FHIR ENDPOINTS DEPLOYED
Yes
FIHR ACTIVE PATIENT RECORDS
100,001 – 250,000
Submit for review
1704

FIG. 17

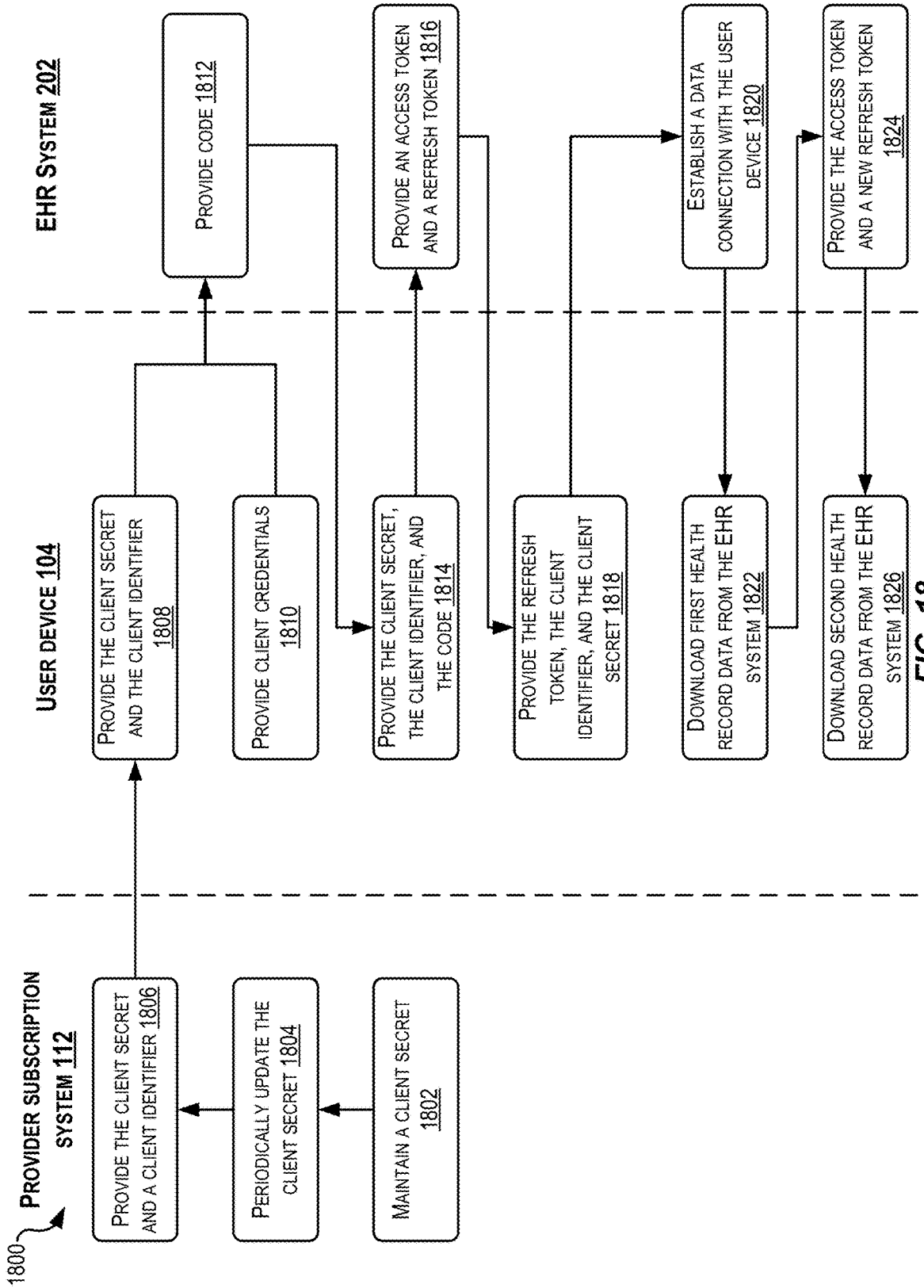
1800
PROVIDER SUBSCRIPTION SYSTEM 112
USER DEVICE 104
EHR SYSTEM 202
MAINTAIN A CLIENT SECRET 1802
PERIODICALLY UPDATE THE CLIENT SECRET 1804
PROVIDE THE CLIENT SECRET AND A CLIENT IDENTIFIER 1806
PROVIDE THE CLIENT SECRET AND THE CLIENT IDENTIFIER 1808
PROVIDE CLIENT CREDENTIALS 1810
PROVIDE CODE 1812
PROVIDE THE CLIENT SECRET, THE CLIENT IDENTIFIER, AND THE CODE 1814
PROVIDE AN ACCESS TOKEN AND A REFRESH TOKEN 1816
PROVIDE THE REFRESH TOKEN, THE CLIENT IDENTIFIER, AND THE CLIENT SECRET 1818
ESTABLISH A DATA CONNECTION WITH THE USER DEVICE 1820
DOWNLOAD FIRST HEALTH RECORD DATA FROM THE EHR SYSTEM 1822
PROVIDE THE ACCESS TOKEN AND A NEW REFRESH TOKEN 1824
DOWNLOAD SECOND HEALTH RECORD DATA FROM THE EHR SYSTEM 1826

FIG. 18

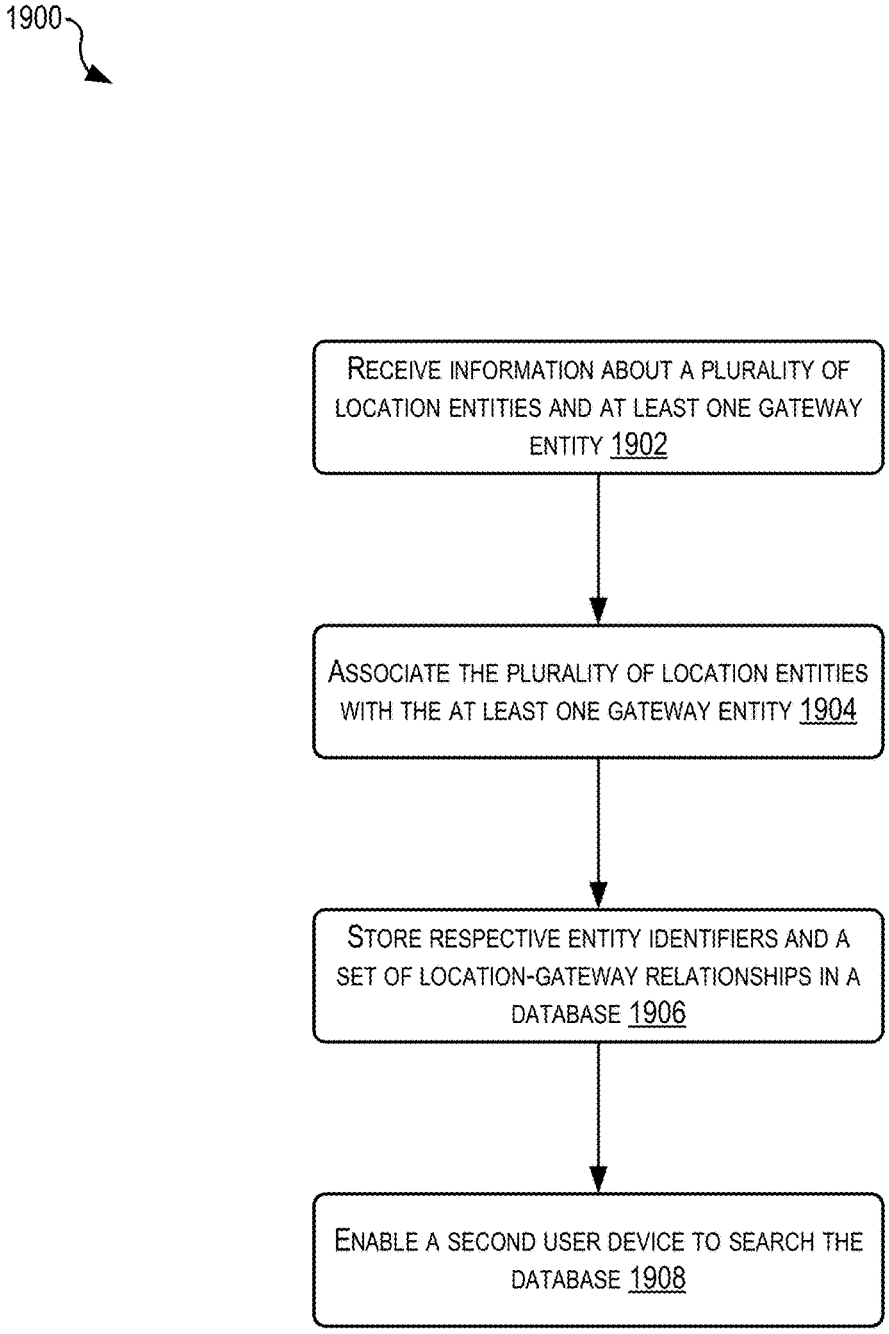
1900
RECEIVE INFORMATION ABOUT A PLURALITY OF LOCATION ENTITIES AND AT LEAST ONE GATEWAY ENTITY 1902
ASSOCIATE THE PLURALITY OF LOCATION ENTITIES WITH THE AT LEAST ONE GATEWAY ENTITY 1904
STORE RESPECTIVE ENTITY IDENTIFIERS AND A SET OF LOCATION-GATEWAY RELATIONSHIPS IN A DATABASE 1906
ENABLE A SECOND USER DEVICE TO SEARCH THE DATABASE 1908

FIG. 19

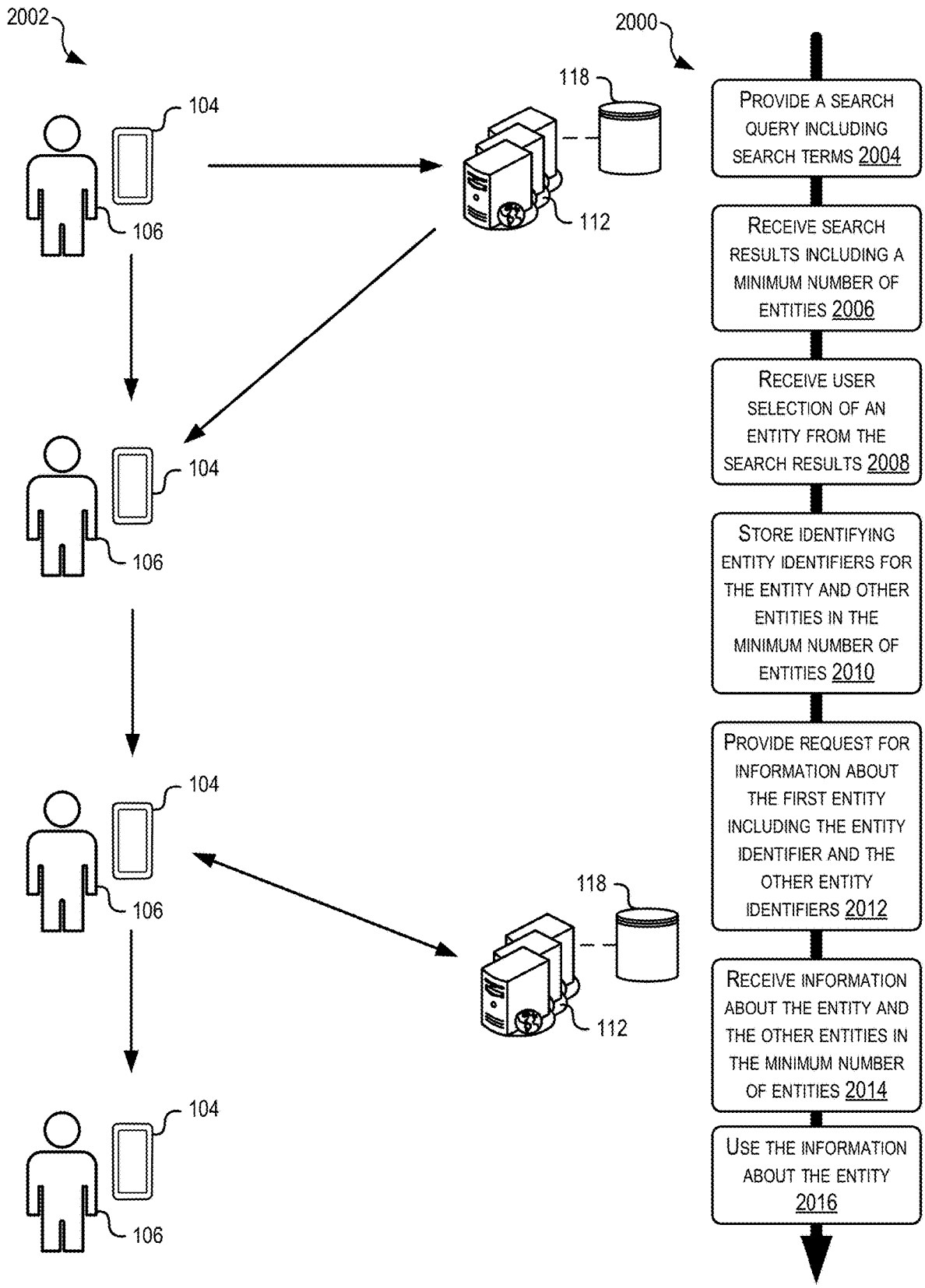
2002
2000
104
106
118
112
PROVIDE A SEARCH QUERY INCLUDING SEARCH TERMS 2004
RECEIVE SEARCH RESULTS INCLUDING A MINIMUM NUMBER OF ENTITIES 2006
RECEIVE USER SELECTION OF AN ENTITY FROM THE SEARCH RESULTS 2008
STORE IDENTIFYING ENTITY IDENTIFIERS FOR THE ENTITY AND OTHER ENTITIES IN THE MINIMUM NUMBER OF ENTITIES 2010
PROVIDE REQUEST FOR INFORMATION ABOUT THE FIRST ENTITY INCLUDING THE ENTITY IDENTIFIER AND THE OTHER ENTITY IDENTIFIERS 2012
RECEIVE INFORMATION ABOUT THE ENTITY AND THE OTHER ENTITIES IN THE MINIMUM NUMBER OF ENTITIES 2014
USE THE INFORMATION ABOUT THE ENTITY 2016

FIG. 20

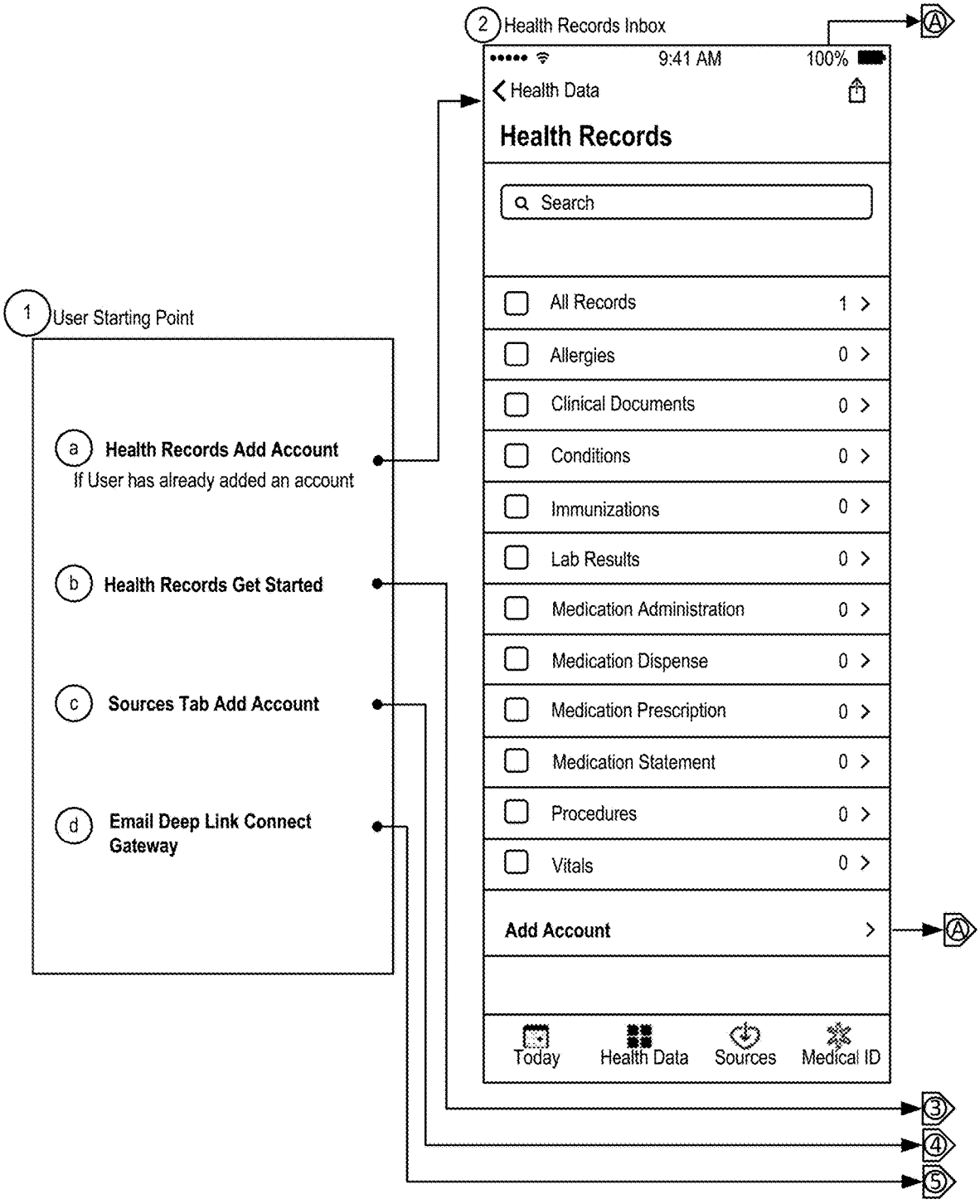
1 User Starting Point
a Health Records Add Account
If User has already added an account
b Health Records Get Started
c Sources Tab Add Account
d Email Deep Link Connect Gateway
2 Health Records Inbox
9:41 AM
100%
Health Data
Health Records
Search
All Records 1
Allergies 0
Clinical Documents 0
Conditions 0
Immunizations 0
Lab Results 0
Medication Administration 0
Medication Dispense 0
Medication Prescription 0
Medication Statement 0
Procedures 0
Vitals 0
Add Account
Today
Health Data
Sources
Medical ID
A
A
3
4
5

FIG. 21

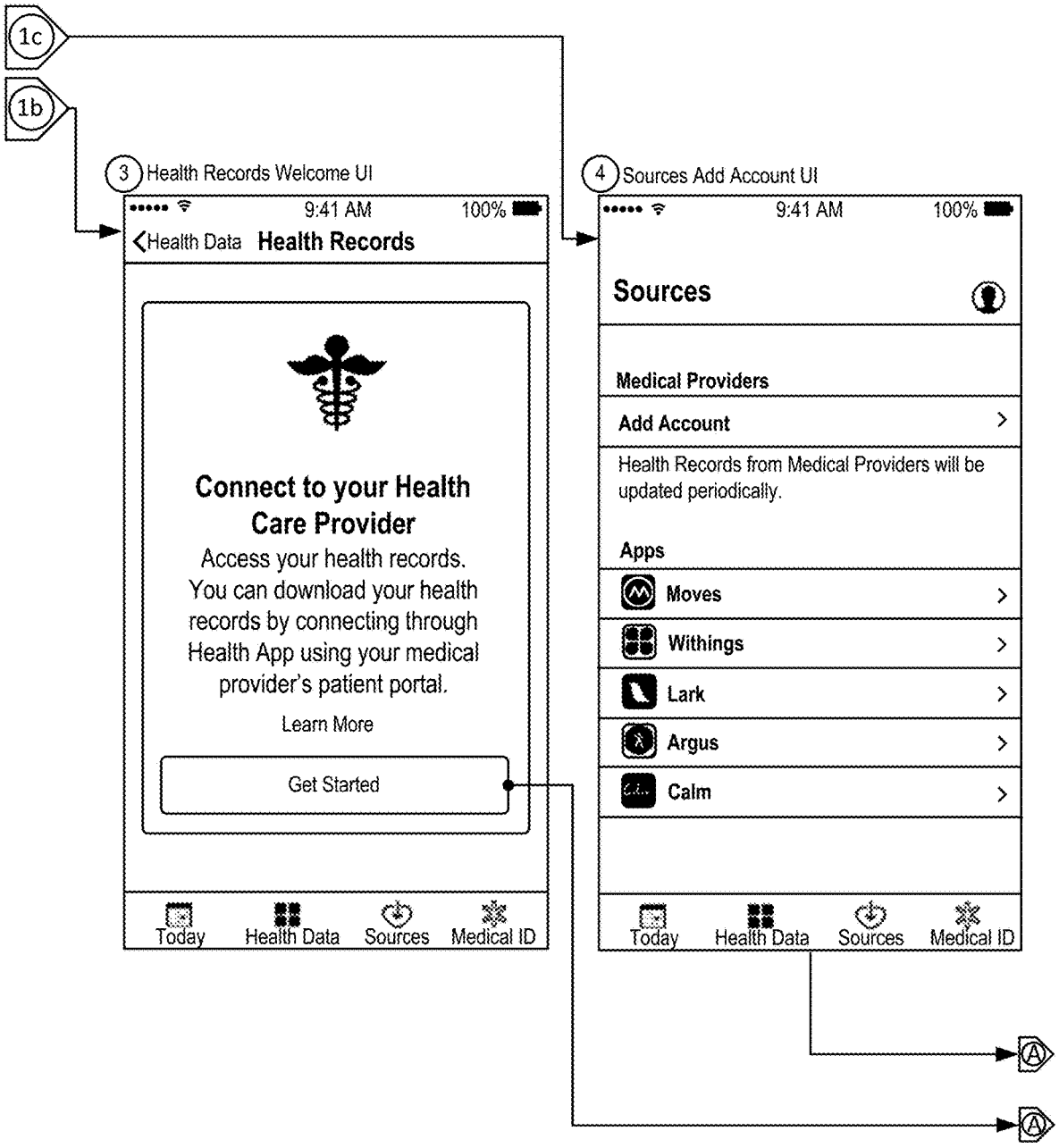
1c
1b
3 Health Records Welcome UI
9:41 AM
100%
Health Data
Health Records
Connect to your Health Care Provider
Access your health records. You can download your health records by connecting through Health App using your medical provider's patient portal.
Learn More
Get Started
Today
Health Data
Sources
Medical ID
4 Sources Add Account UI
9:41 AM
100%
Sources
Medical Providers
Add Account
Health Records from Medical Providers will be updated periodically.
Apps
Moves
Withings
Lark
Argus
Calm
Today
Health Data
Sources
Medical ID
A
A

FIG. 22

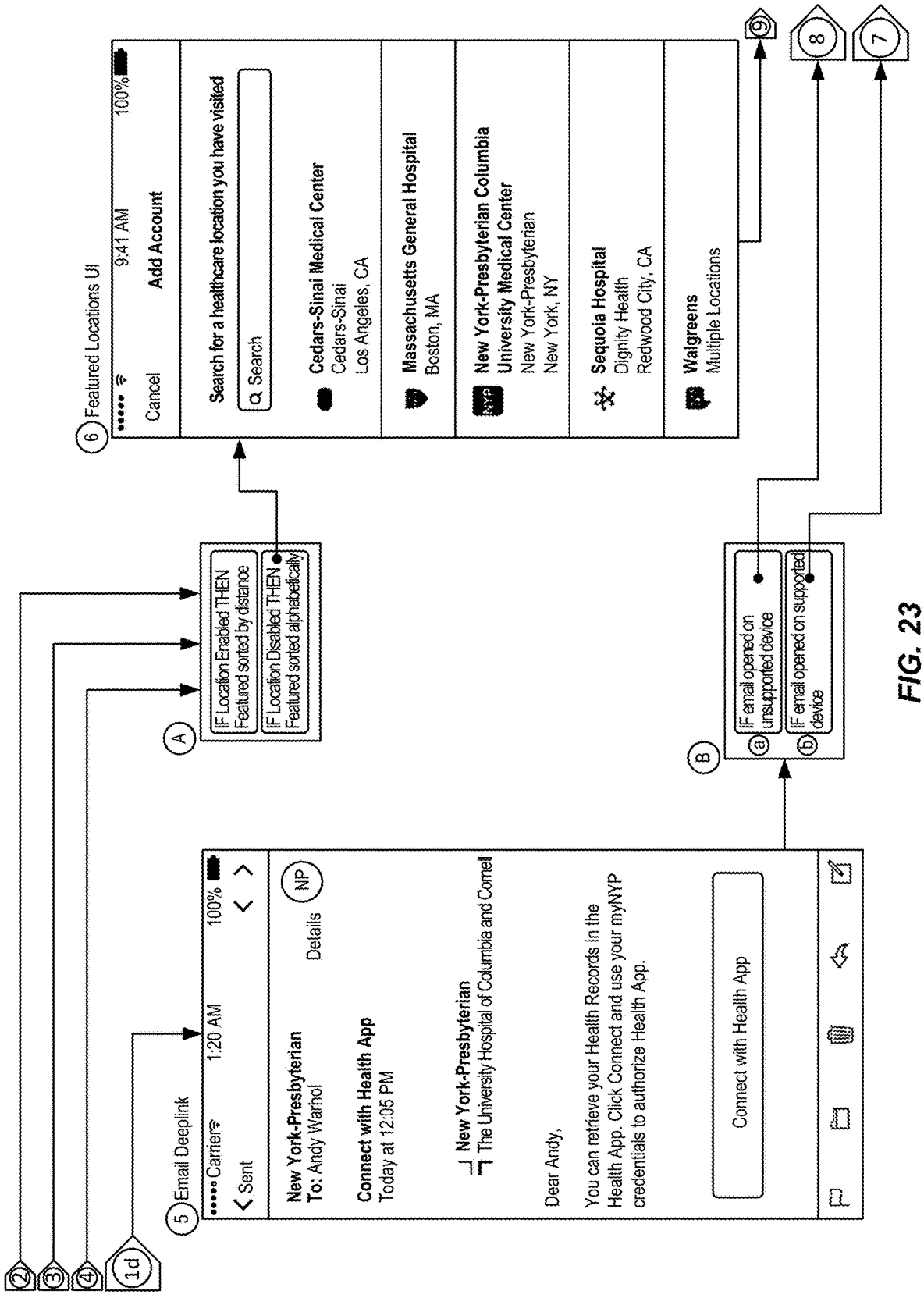
1d
2
3
4
5 Email Deeplink
Carrier 1:20 AM 100%
Sent
New York-Presbyterian
To: Andy Warhol
Details
NP
Connect with Health App
Today at 12:05 PM
New York-Presbyterian
The University Hospital of Columbia and Cornell
Dear Andy,
You can retrieve your Health Records in the Health App. Click Connect and use your myNYP credentials to authorize Health App.
Connect with Health App
A
IF Location Enabled THEN Featured sorted by distance
IF Location Disabled THEN Featured sorted alphabetically
6 Featured Locations UI
9:41 AM 100%
Cancel
Add Account
Search for a healthcare location you have visited
Search
Cedars-Sinai Medical Center
Cedars-Sinai
Los Angeles, CA
Massachusetts General Hospital
Boston, MA
New York-Presbyterian Columbia University Medical Center
New York-Presbyterian
New York, NY
Sequoia Hospital
Dignity Health
Redwood City, CA
Walgreens
Multiple Locations
9
8
7
B
a IF email opened on unsupported device
b IF email opened on supported device

FIG. 23

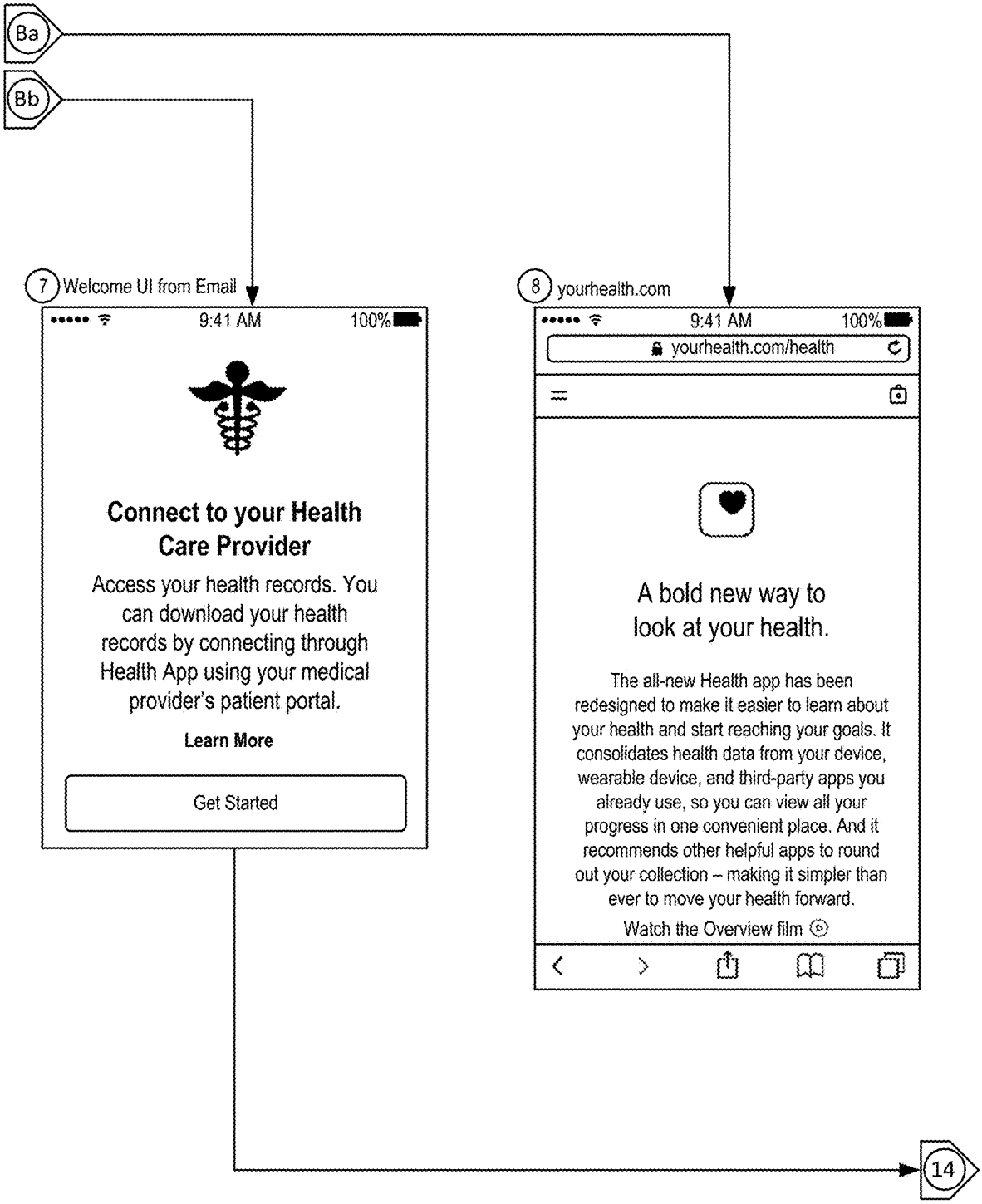
Ba
Bb
7 Welcome UI from Email
9:41 AM
100%
Connect to your Health Care Provider
Access your health records. You can download your health records by connecting through Health App using your medical provider's patient portal.
Learn More
Get Started
8 yourhealth.com
9:41 AM
100%
yourhealth.com/health
A bold new way to look at your health.
The all-new Health app has been redesigned to make it easier to learn about your health and start reaching your goals. It consolidates health data from your device, wearable device, and third-party apps you already use, so you can view all your progress in one convenient place. And it recommends other helpful apps to round out your collection – making it simpler than ever to move your health forward.
Watch the Overview film
14

FIG. 24

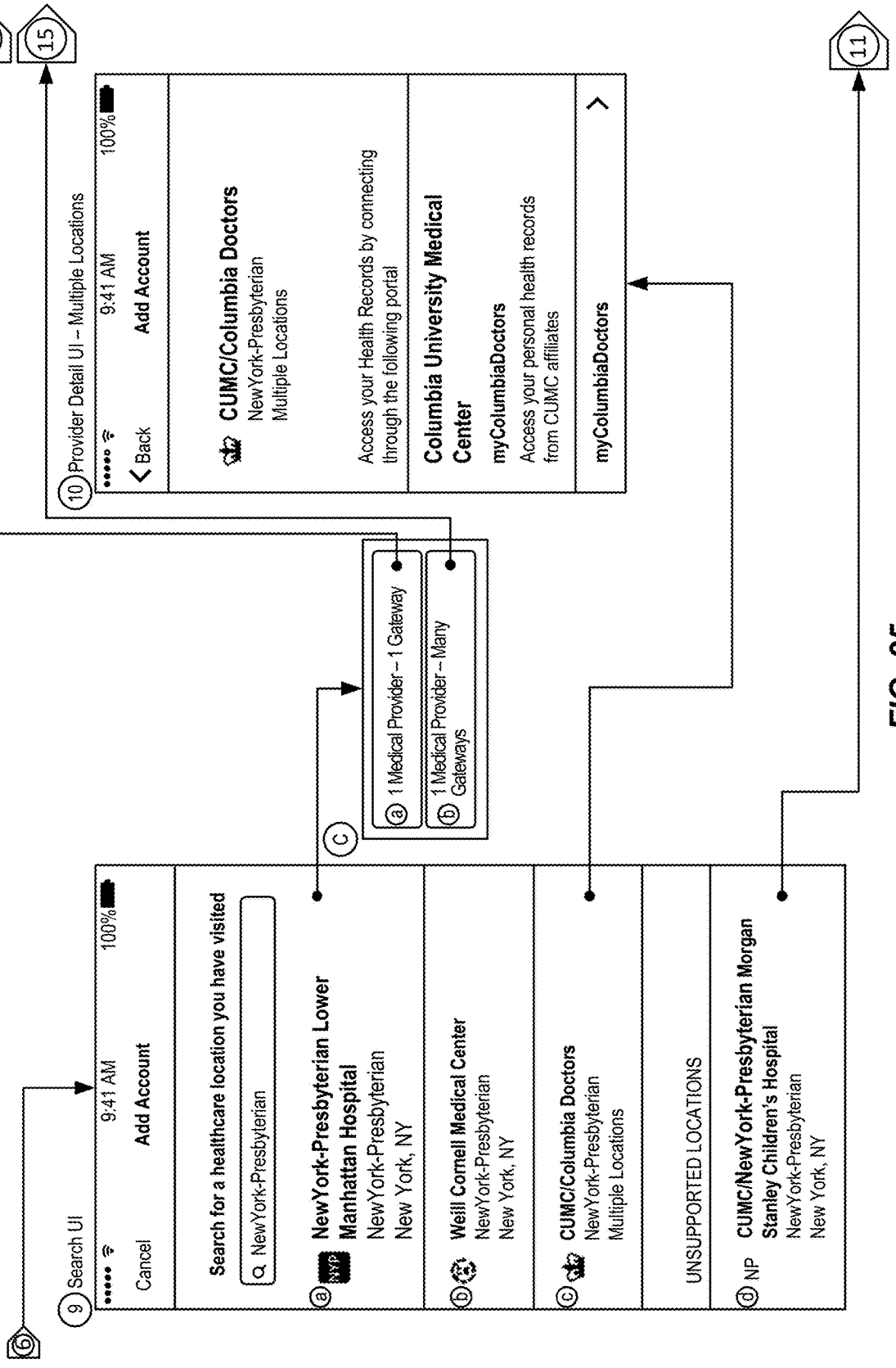
14
15
10 Provider Detail UI – Multiple Locations
9:41 AM
100%
Back
Add Account
CUMC/Columbia Doctors
NewYork-Presbyterian
Multiple Locations
Access your Health Records by connecting through the following portal
Columbia University Medical Center
myColumbiaDoctors
Access your personal health records from CUMC affiliates
myColumbiaDoctors
1 Medical Provider – 1 Gateway
1 Medical Provider – Many Gateways
6
9 Search UI
9:41 AM
100%
Cancel
Add Account
Search for a healthcare location you have visited
NewYork-Presbyterian
NewYork-Presbyterian Lower Manhattan Hospital
NewYork-Presbyterian
New York, NY
Weill Cornell Medical Center
NewYork-Presbyterian
New York, NY
CUMC/Columbia Doctors
NewYork-Presbyterian
Multiple Locations
UNSUPPORTED LOCATIONS
NP
CUMC/NewYork-Presbyterian Morgan Stanley Children's Hospital
NewYork-Presbyterian
New York, NY
11

FIG. 25

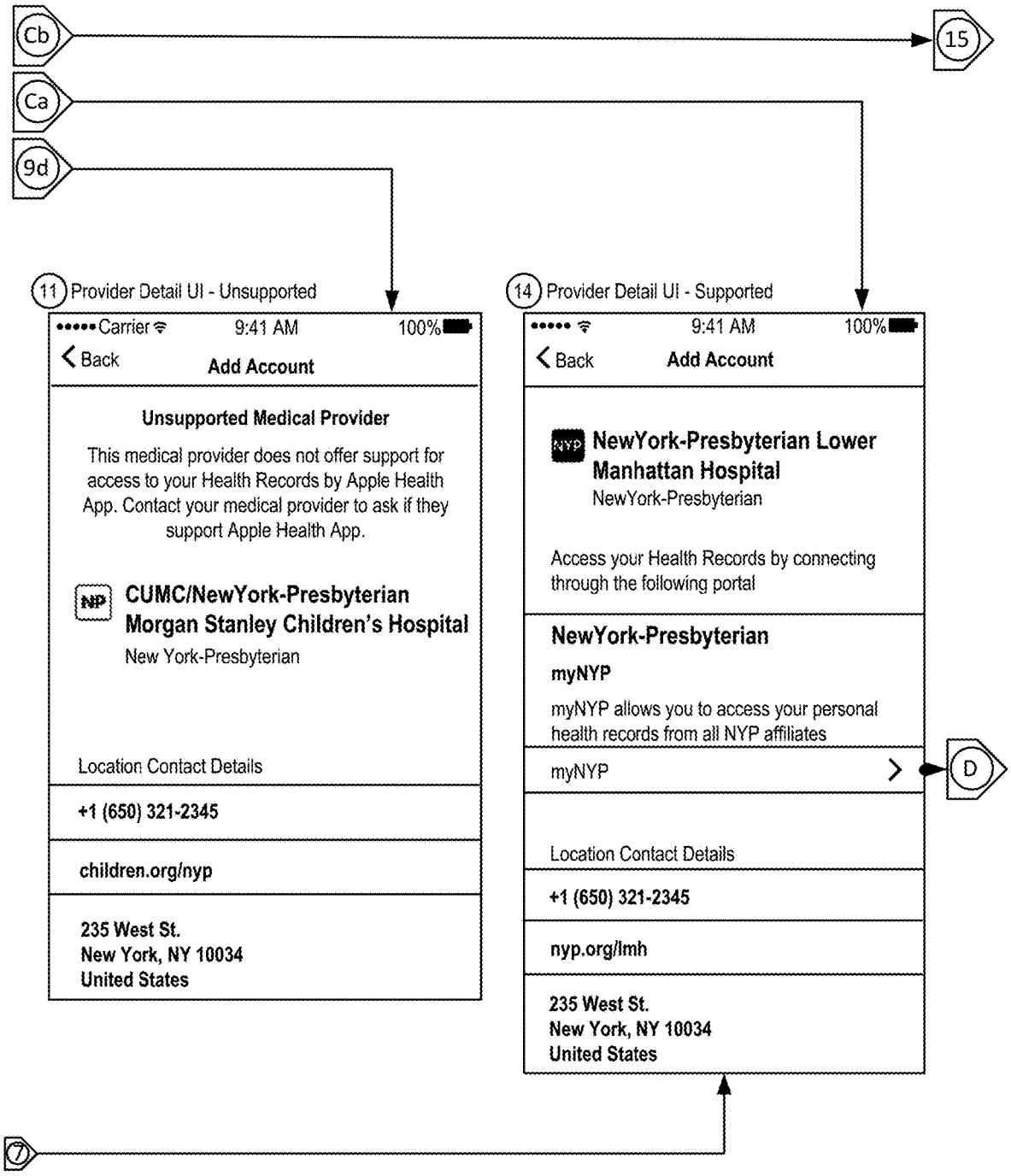
Cb
15
Ca
9d
11 Provider Detail UI - Unsupported
Carrier 9:41 AM 100%
Back
Add Account
Unsupported Medical Provider
This medical provider does not offer support for access to your Health Records by Apple Health App. Contact your medical provider to ask if they support Apple Health App.
CUMC/NewYork-Presbyterian Morgan Stanley Children's Hospital
New York-Presbyterian
Location Contact Details
+1 (650) 321-2345
children.org/nyp
235 West St.
New York, NY 10034
United States
14 Provider Detail UI - Supported
9:41 AM 100%
Back
Add Account
NewYork-Presbyterian Lower Manhattan Hospital
NewYork-Presbyterian
Access your Health Records by connecting through the following portal
NewYork-Presbyterian
myNYP
myNYP allows you to access your personal health records from all NYP affiliates
myNYP
D
Location Contact Details
+1 (650) 321-2345
nyp.org/lmh
235 West St.
New York, NY 10034
United States
7

FIG. 26

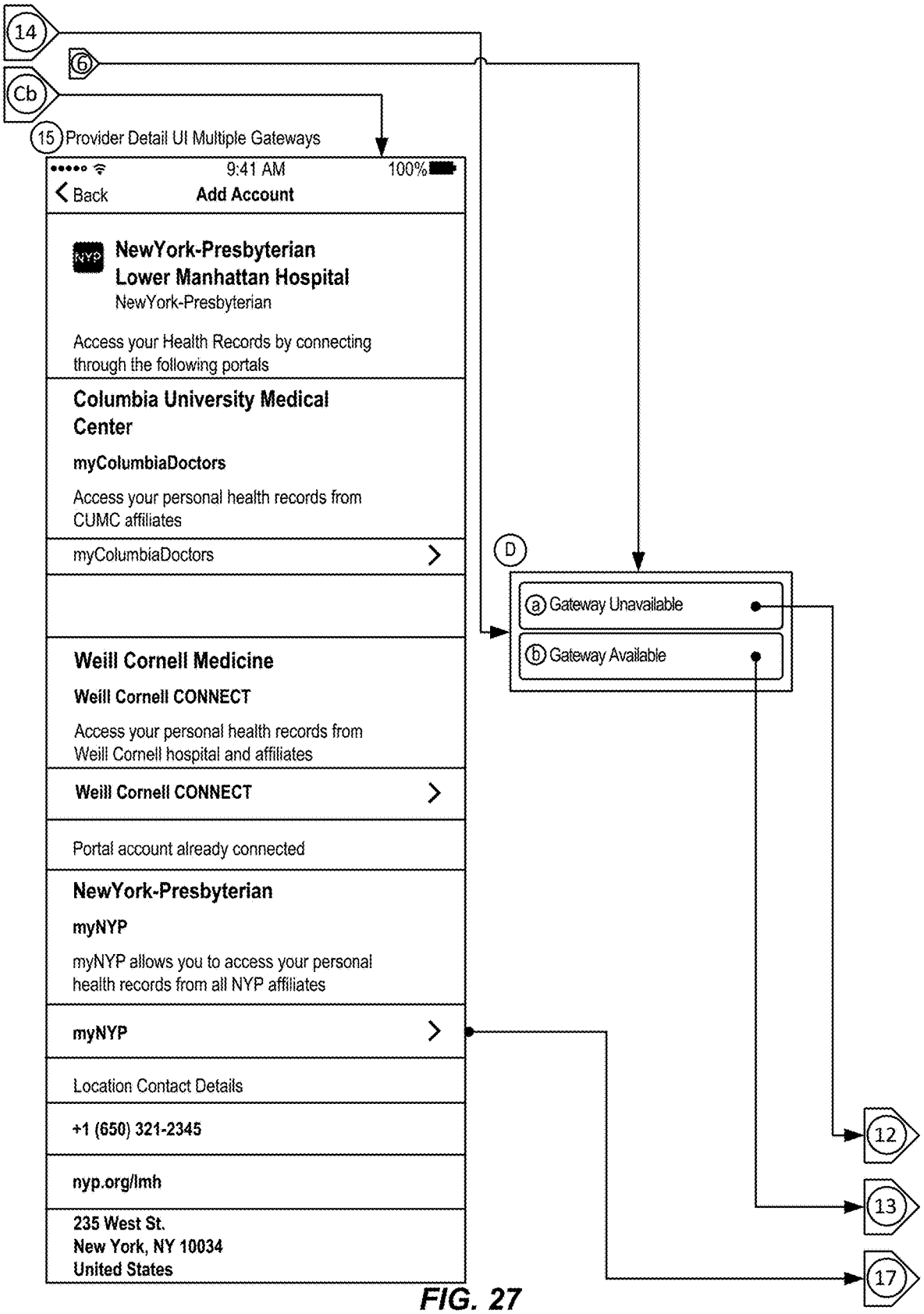
14
6
Cb
15 Provider Detail UI Multiple Gateways
9:41 AM
100%
Back
Add Account
NewYork-Presbyterian
Lower Manhattan Hospital
NewYork-Presbyterian
Access your Health Records by connecting through the following portals
Columbia University Medical Center
myColumbiaDoctors
Access your personal health records from CUMC affiliates
myColumbiaDoctors
Weill Cornell Medicine
Weill Cornell CONNECT
Access your personal health records from Weill Cornell hospital and affiliates
Weill Cornell CONNECT
Portal account already connected
NewYork-Presbyterian
myNYP
myNYP allows you to access your personal health records from all NYP affiliates
myNYP
Location Contact Details
+1 (650) 321-2345
nyp.org/lmh
235 West St.
New York, NY 10034
United States
D
a Gateway Unavailable
b Gateway Available
12
13
17

FIG. 27

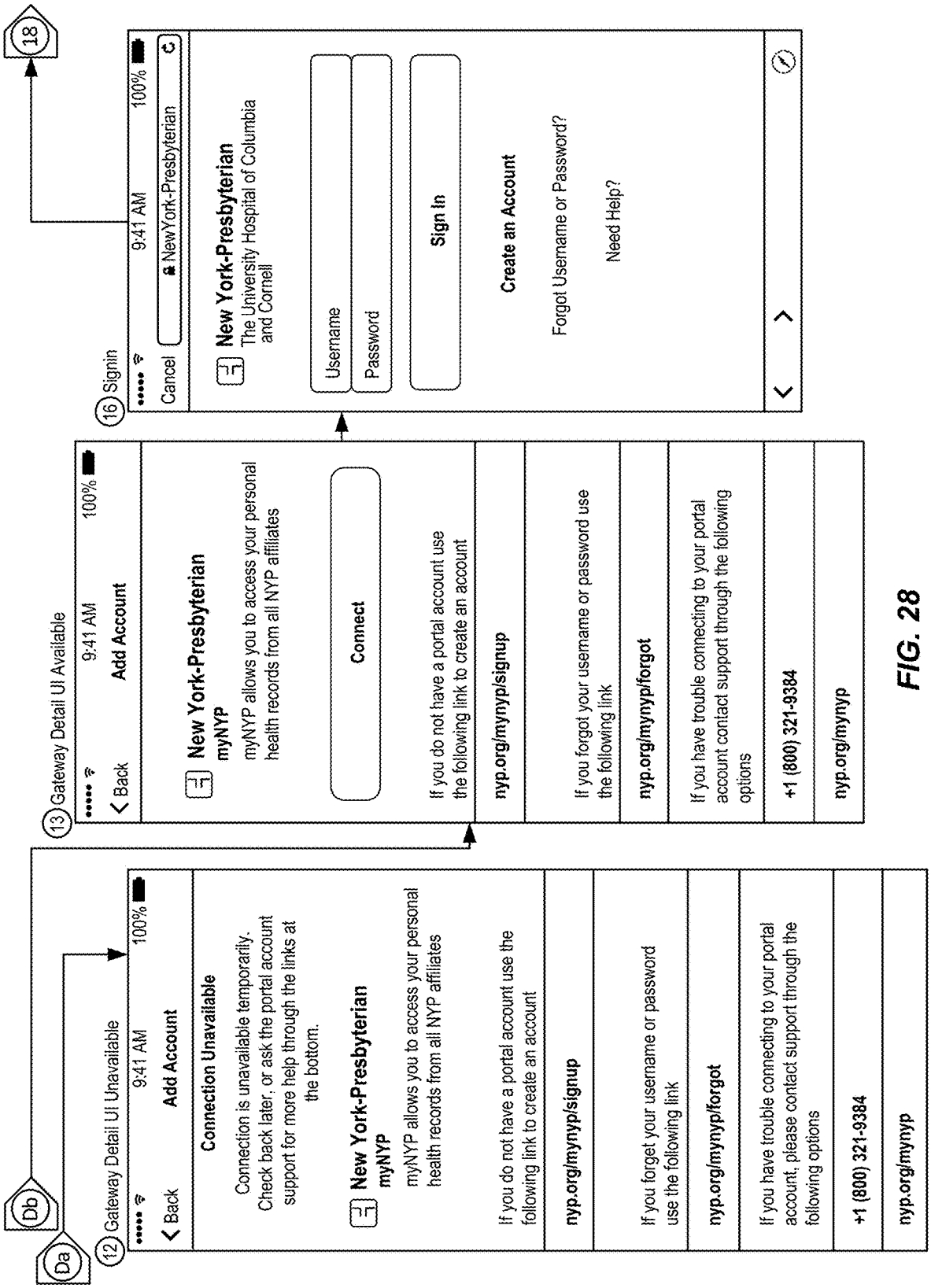
Da
Db
12 Gateway Detail UI Unavailable
Back
9:41 AM
100%
Add Account
Connection Unavailable
Connection is unavailable temporarily. Check back later, or ask the portal account support for more help through the links at the bottom.
New York-Presbyterian
myNYP
myNYP allows you to access your personal health records from all NYP affiliates
If you do not have a portal account use the following link to create an account
nyp.org/mynyp/signup
If you forget your username or password use the following link
nyp.org/mynyp/forgot
If you have trouble connecting to your portal account, please contact support through the following options
+1 (800) 321-9384
nyp.org/mynyp
13 Gateway Detail UI Available
Back
9:41 AM
100%
Add Account
New York-Presbyterian
myNYP
myNYP allows you to access your personal health records from all NYP affiliates
Connect
If you do not have a portal account use the following link to create an account
nyp.org/mynyp/signup
If you forgot your username or password use the following link
nyp.org/mynyp/forgot
If you have trouble connecting to your portal account contact support through the following options
+1 (800) 321-9384
nyp.org/mynyp
16 Signin
Cancel
NewYork-Presbyterian
9:41 AM
100%
New York-Presbyterian
The University Hospital of Columbia and Cornell
Username
Password
Sign In
Create an Account
Forgot Username or Password?
Need Help?
18

FIG. 28

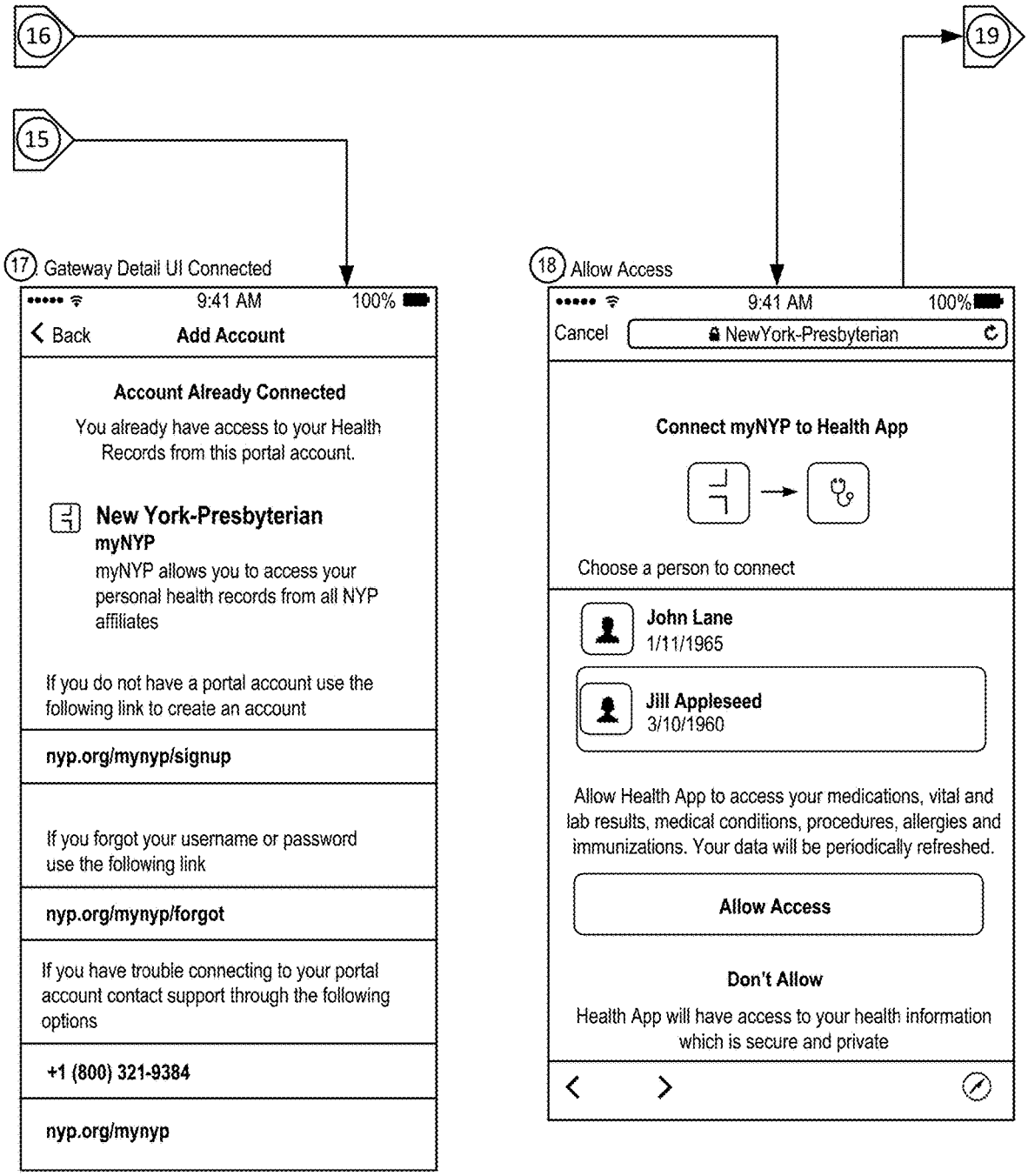
16
19
15
17 Gateway Detail UI Connected
9:41 AM
100%
Back
Add Account
Account Already Connected
You already have access to your Health Records from this portal account.
New York-Presbyterian
myNYP
myNYP allows you to access your personal health records from all NYP affiliates
If you do not have a portal account use the following link to create an account
nyp.org/mynyp/signup
If you forgot your username or password use the following link
nyp.org/mynyp/forgot
If you have trouble connecting to your portal account contact support through the following options
+1 (800) 321-9384
nyp.org/mynyp
18 Allow Access
9:41 AM
100%
Cancel
NewYork-Presbyterian
Connect myNYP to Health App
Choose a person to connect
John Lane
1/11/1965
Jill Appleseed
3/10/1960
Allow Health App to access your medications, vital and lab results, medical conditions, procedures, allergies and immunizations. Your data will be periodically refreshed.
Allow Access
Don't Allow
Health App will have access to your health information which is secure and private

FIG. 29

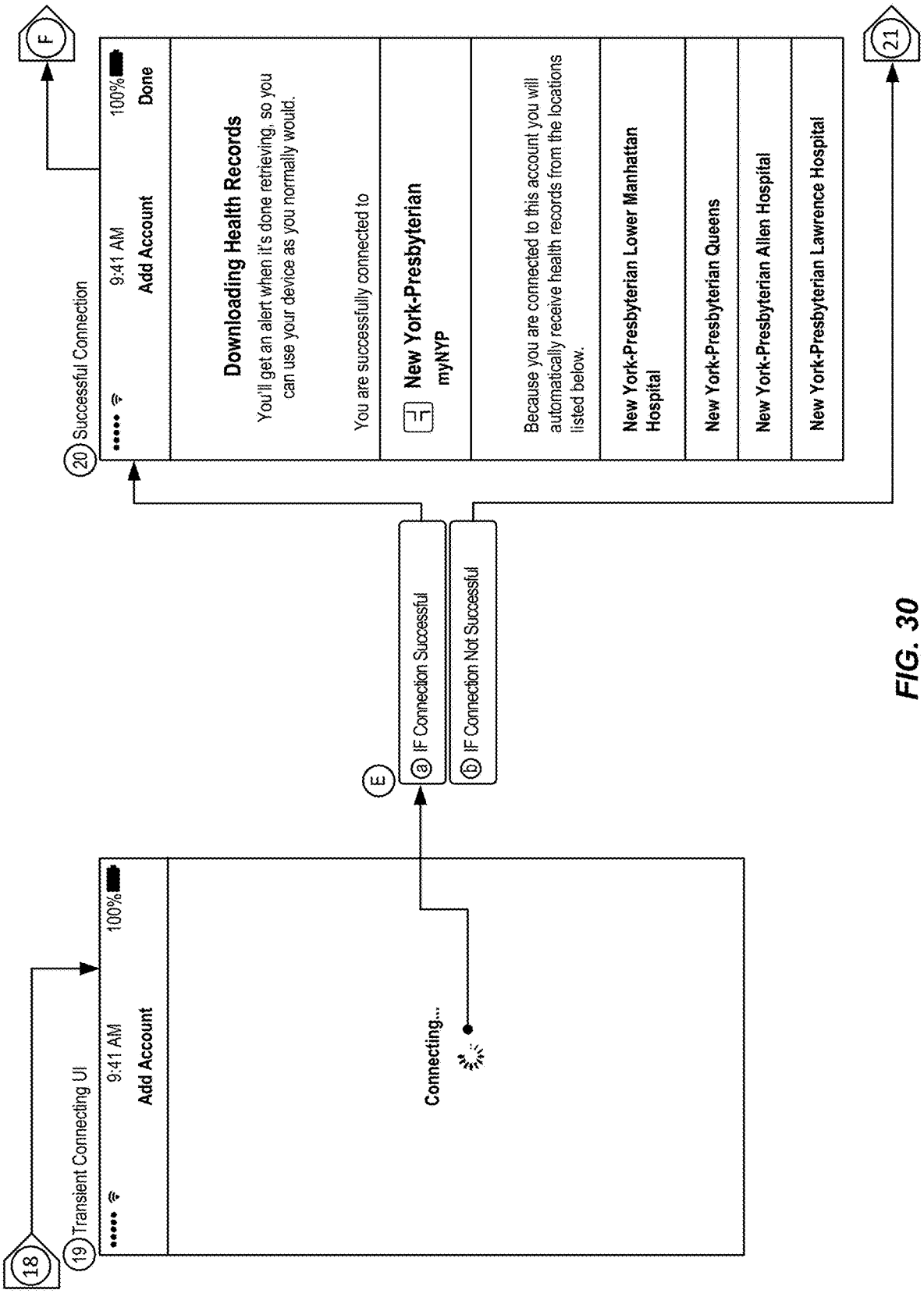
18
19 Transient Connecting UI
9:41 AM
100%
Add Account
Connecting...
E
ⓐ IF Connection Successful
ⓑ IF Connection Not Successful
20 Successful Connection
9:41 AM
100%
Add Account
Done
Downloading Health Records
You'll get an alert when it's done retrieving, so you can use your device as you normally would.
You are successfully connected to
New York-Presbyterian
myNYP
Because you are connected to this account you will automatically receive health records from the locations listed below.
New York-Presbyterian Lower Manhattan Hospital
New York-Presbyterian Queens
New York-Presbyterian Allen Hospital
New York-Presbyterian Lawrence Hospital
F
21

FIG. 30

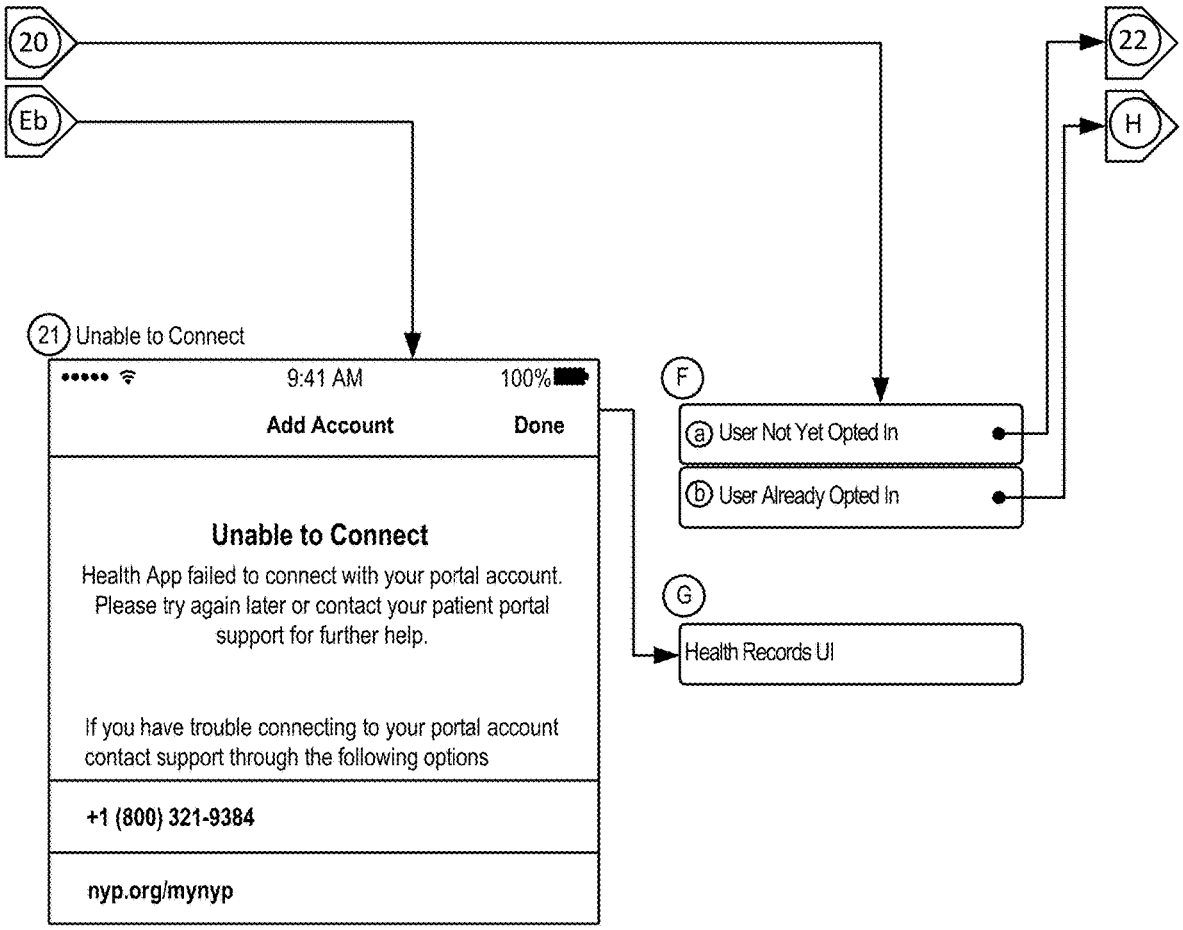
20
Eb
22
H
21 Unable to Connect
9:41 AM
100%
Add Account
Done
Unable to Connect
Health App failed to connect with your portal account. Please try again later or contact your patient portal support for further help.
If you have trouble connecting to your portal account contact support through the following options
+1 (800) 321-9384
nyp.org/mynyp
F
a User Not Yet Opted In
b User Already Opted In
G
Health Records UI

FIG. 31

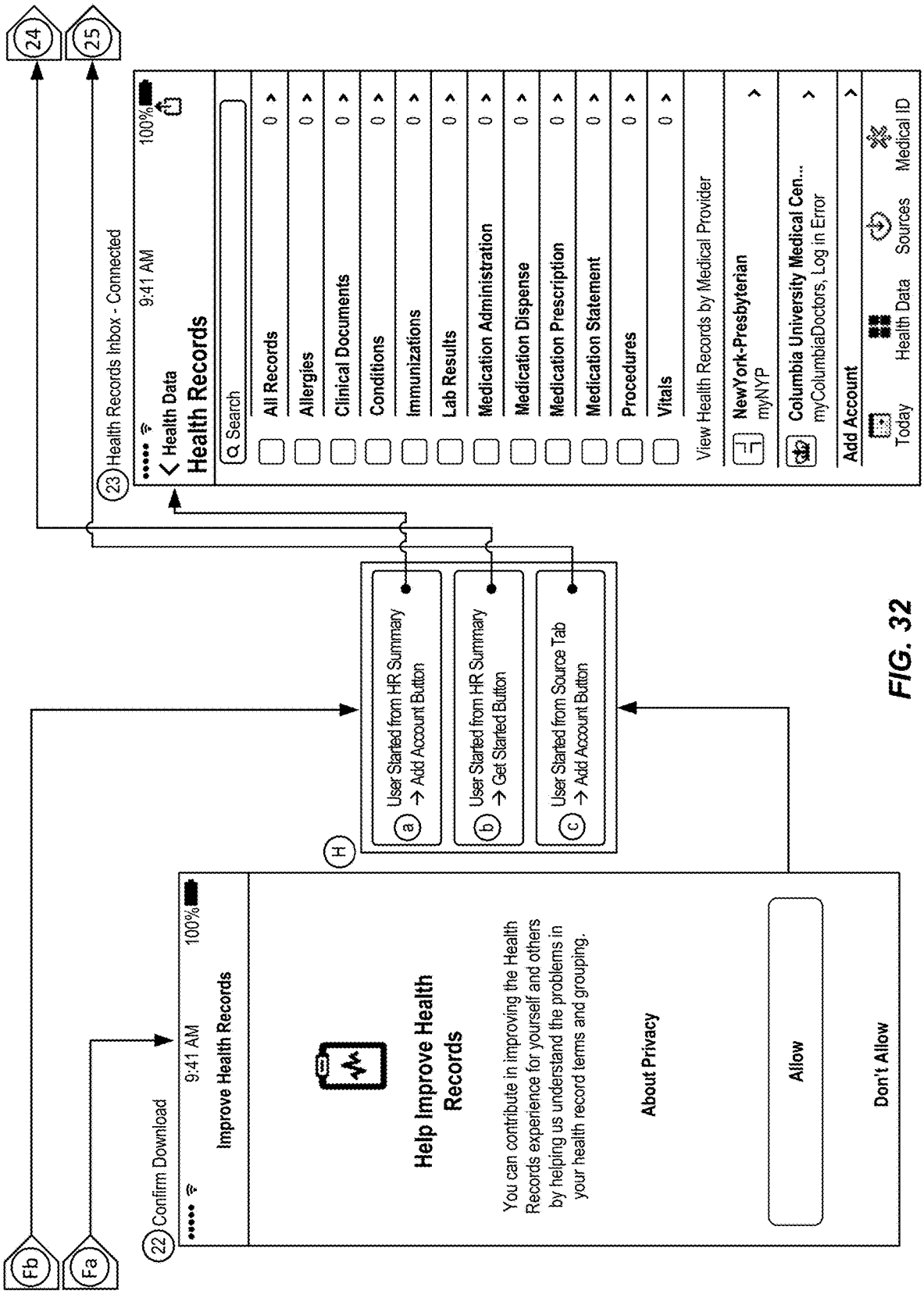
Fb
Fa
22 Confirm Download
9:41 AM
100%
Improve Health Records
Help Improve Health Records
You can contribute in improving the Health Records experience for yourself and others by helping us understand the problems in your health record terms and grouping.
About Privacy
Allow
Don't Allow
H
a User Started from HR Summary → Add Account Button
b User Started from HR Summary → Get Started Button
c User Started from Source Tab → Add Account Button
23 Health Records Inbox - Connected
9:41 AM
100%
Health Data
Health Records
Search
All Records 0
Allergies 0
Clinical Documents 0
Conditions 0
Immunizations 0
Lab Results 0
Medication Administration 0
Medication Dispense 0
Medication Prescription 0
Medication Statement 0
Procedures 0
Vitals 0
View Health Records by Medical Provider
NewYork-Presbyterian
myNYP
Columbia University Medical Cen...
myColumbiaDoctors, Log in Error
Add Account
Today
Health Data
Sources
Medical ID
24
25

FIG. 32

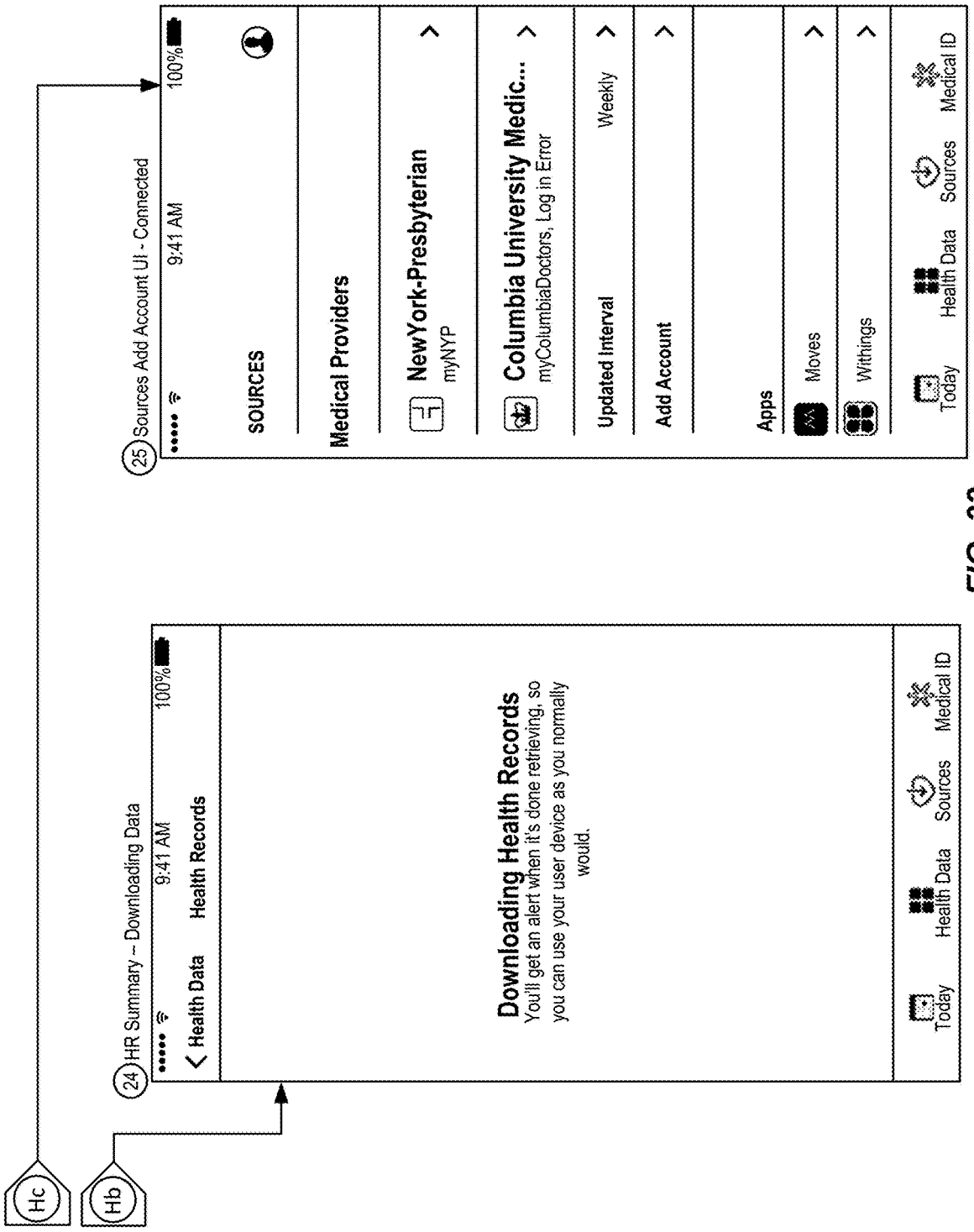
Hc
Hb
24 HR Summary – Downloading Data
9:41 AM
100%
Health Data
Health Records
Downloading Health Records
You'll get an alert when it's done retrieving, so you can use your user device as you normally would.
Today
Health Data
Sources
Medical ID
25 Sources Add Account UI - Connected
9:41 AM
100%
SOURCES
Medical Providers
NewYork-Presbyterian
myNYP
Columbia University Medic...
myColumbiaDoctors, Log in Error
Updated Interval
Weekly
Add Account
Apps
Moves
Withings
Today
Health Data
Sources
Medical ID

FIG. 33

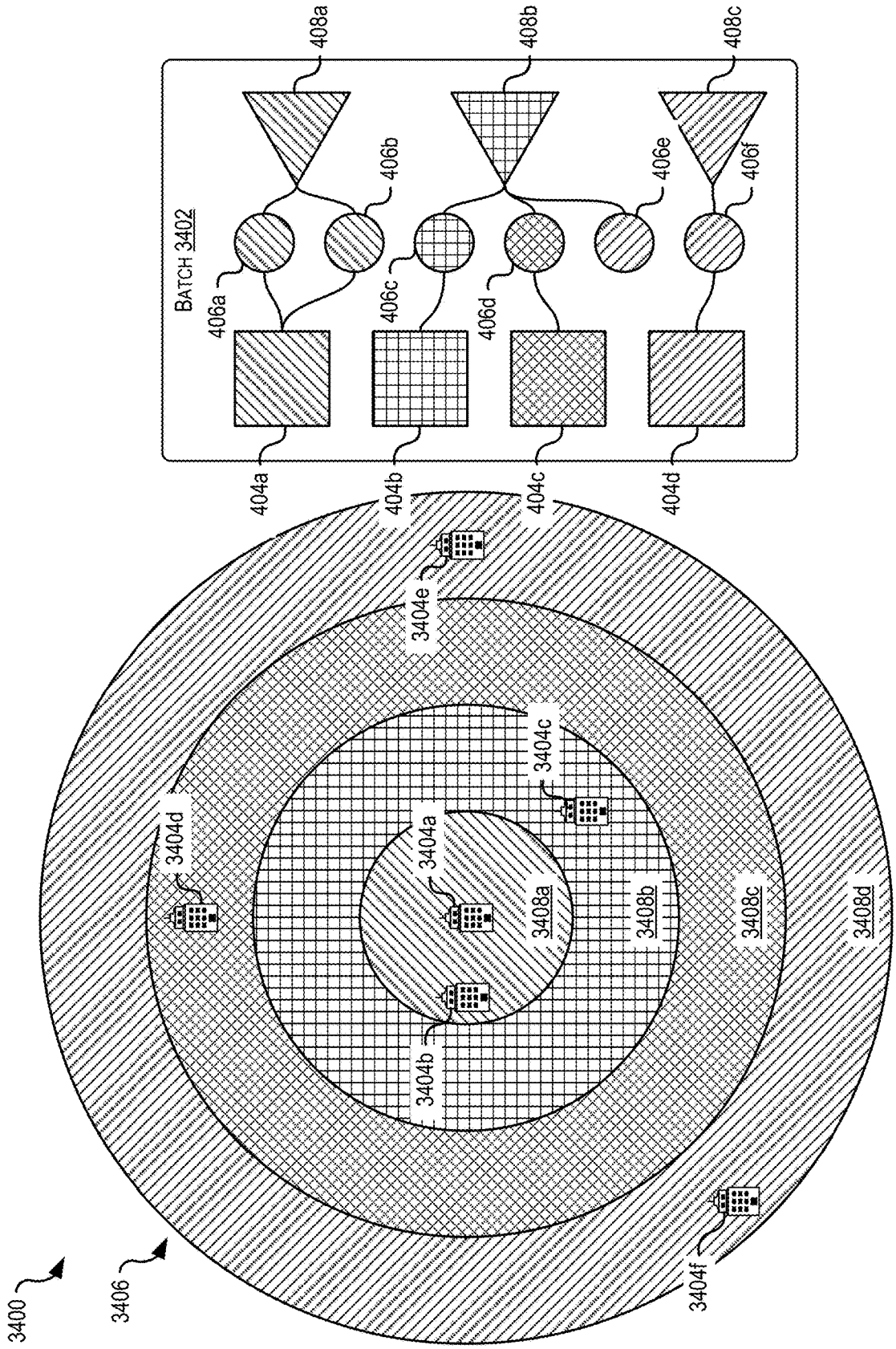
3400
3406
3404f
3404d
3404e
3404c
3404a
3404b
3408a
3408b
3408c
3408d
404a
404b
404c
404d
BATCH 3402
406a
406b
406c
406d
406e
406f
408a
408b
408c

FIG. 34

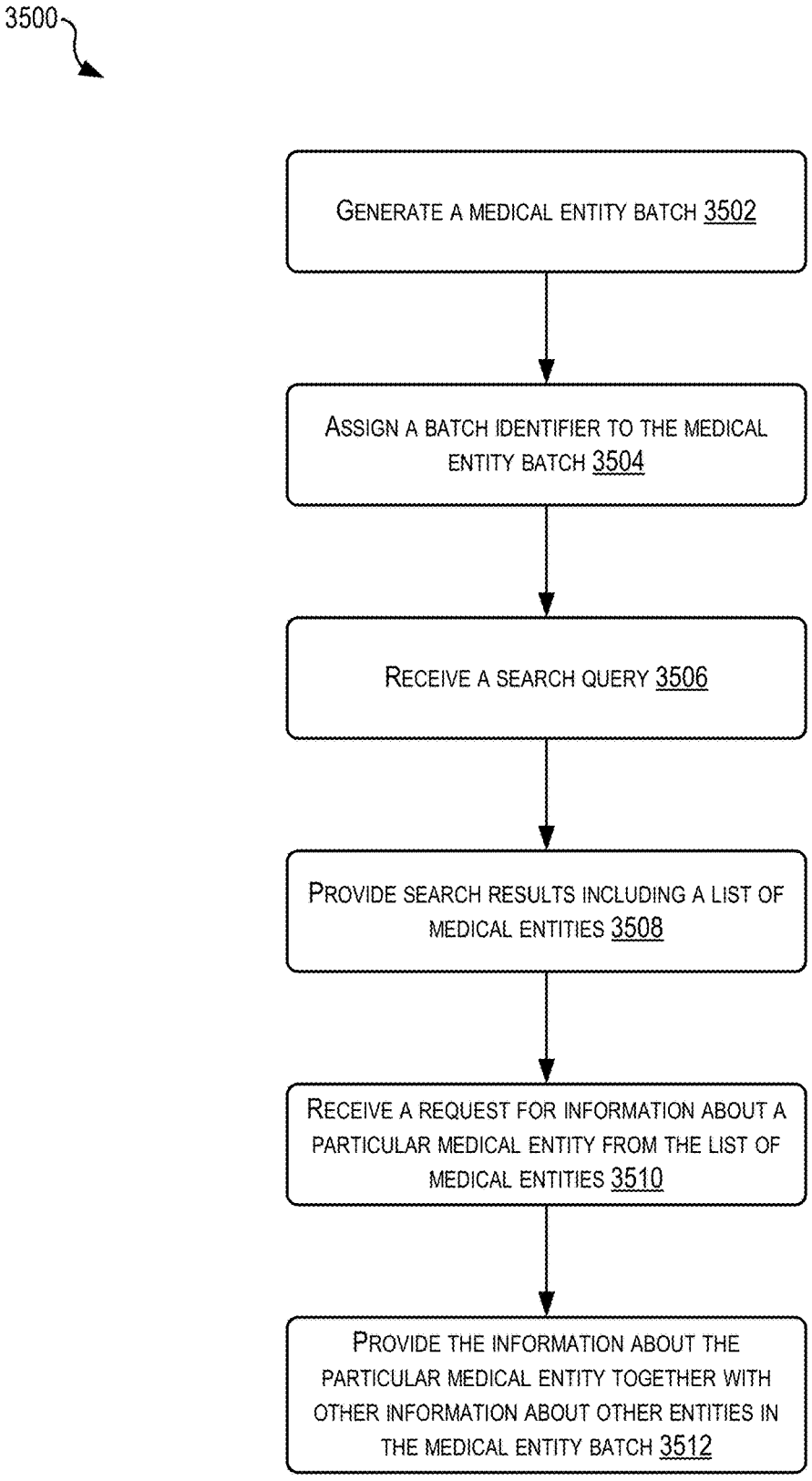
3500
GENERATE A MEDICAL ENTITY BATCH 3502
ASSIGN A BATCH IDENTIFIER TO THE MEDICAL ENTITY BATCH 3504
RECEIVE A SEARCH QUERY 3506
PROVIDE SEARCH RESULTS INCLUDING A LIST OF MEDICAL ENTITIES 3508
RECEIVE A REQUEST FOR INFORMATION ABOUT A PARTICULAR MEDICAL ENTITY FROM THE LIST OF MEDICAL ENTITIES 3510
PROVIDE THE INFORMATION ABOUT THE PARTICULAR MEDICAL ENTITY TOGETHER WITH OTHER INFORMATION ABOUT OTHER ENTITIES IN THE MEDICAL ENTITY BATCH 3512

FIG. 35

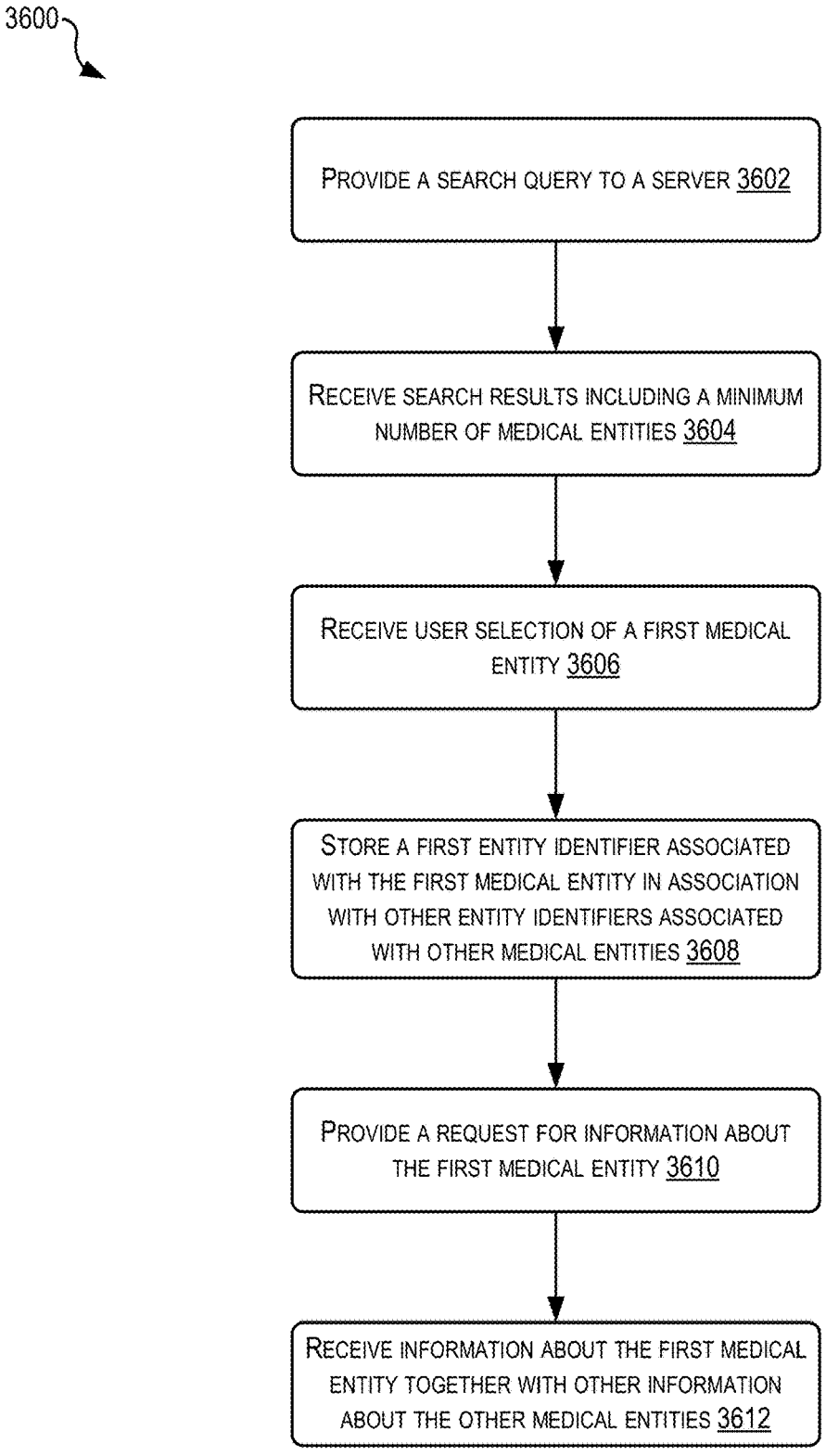
3600
PROVIDE A SEARCH QUERY TO A SERVER 3602
RECEIVE SEARCH RESULTS INCLUDING A MINIMUM NUMBER OF MEDICAL ENTITIES 3604
RECEIVE USER SELECTION OF A FIRST MEDICAL ENTITY 3606
STORE A FIRST ENTITY IDENTIFIER ASSOCIATED WITH THE FIRST MEDICAL ENTITY IN ASSOCIATION WITH OTHER ENTITY IDENTIFIERS ASSOCIATED WITH OTHER MEDICAL ENTITIES 3608
PROVIDE A REQUEST FOR INFORMATION ABOUT THE FIRST MEDICAL ENTITY 3610
RECEIVE INFORMATION ABOUT THE FIRST MEDICAL ENTITY TOGETHER WITH OTHER INFORMATION ABOUT THE OTHER MEDICAL ENTITIES 3612

FIG. 36

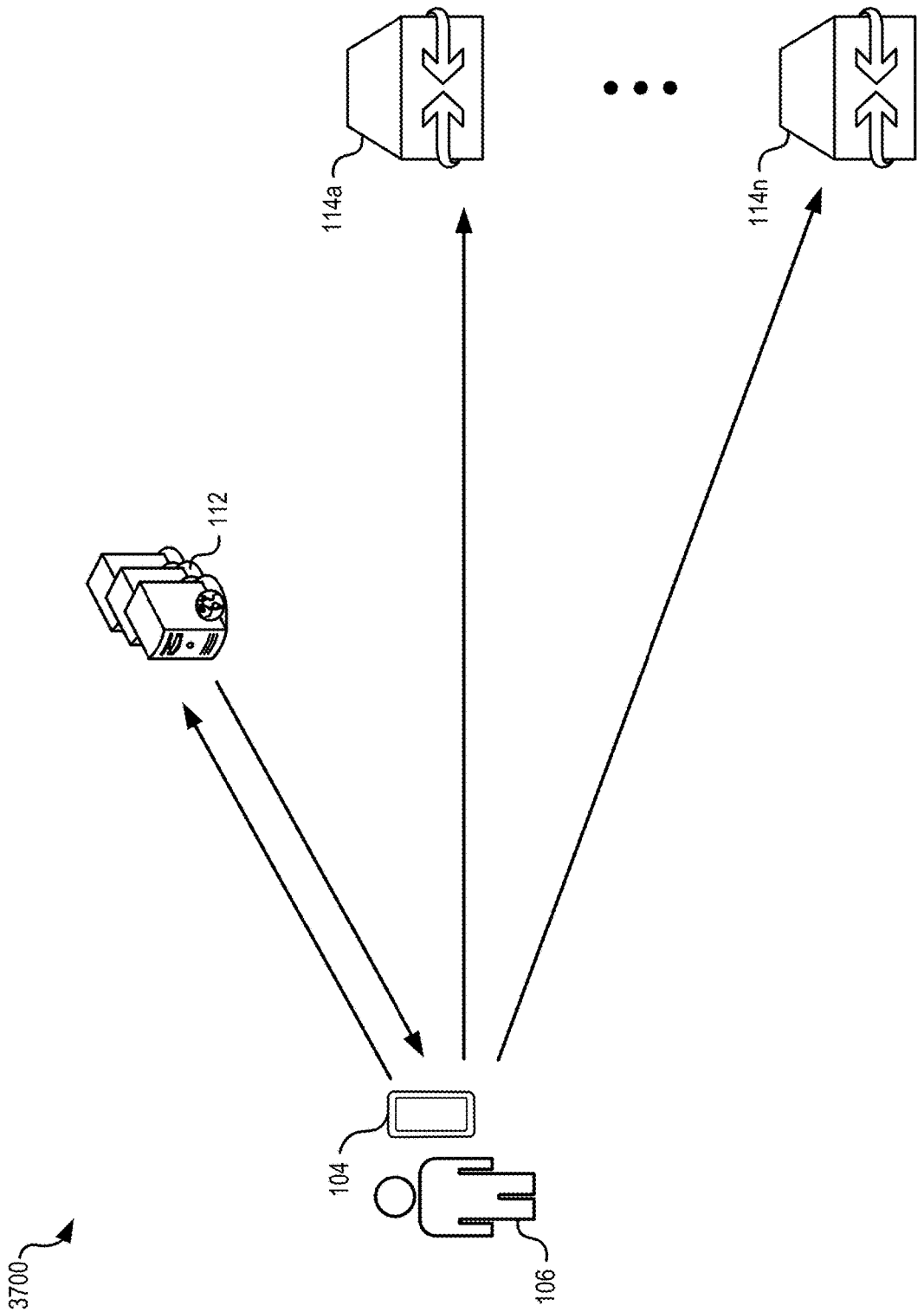

FIG. 37

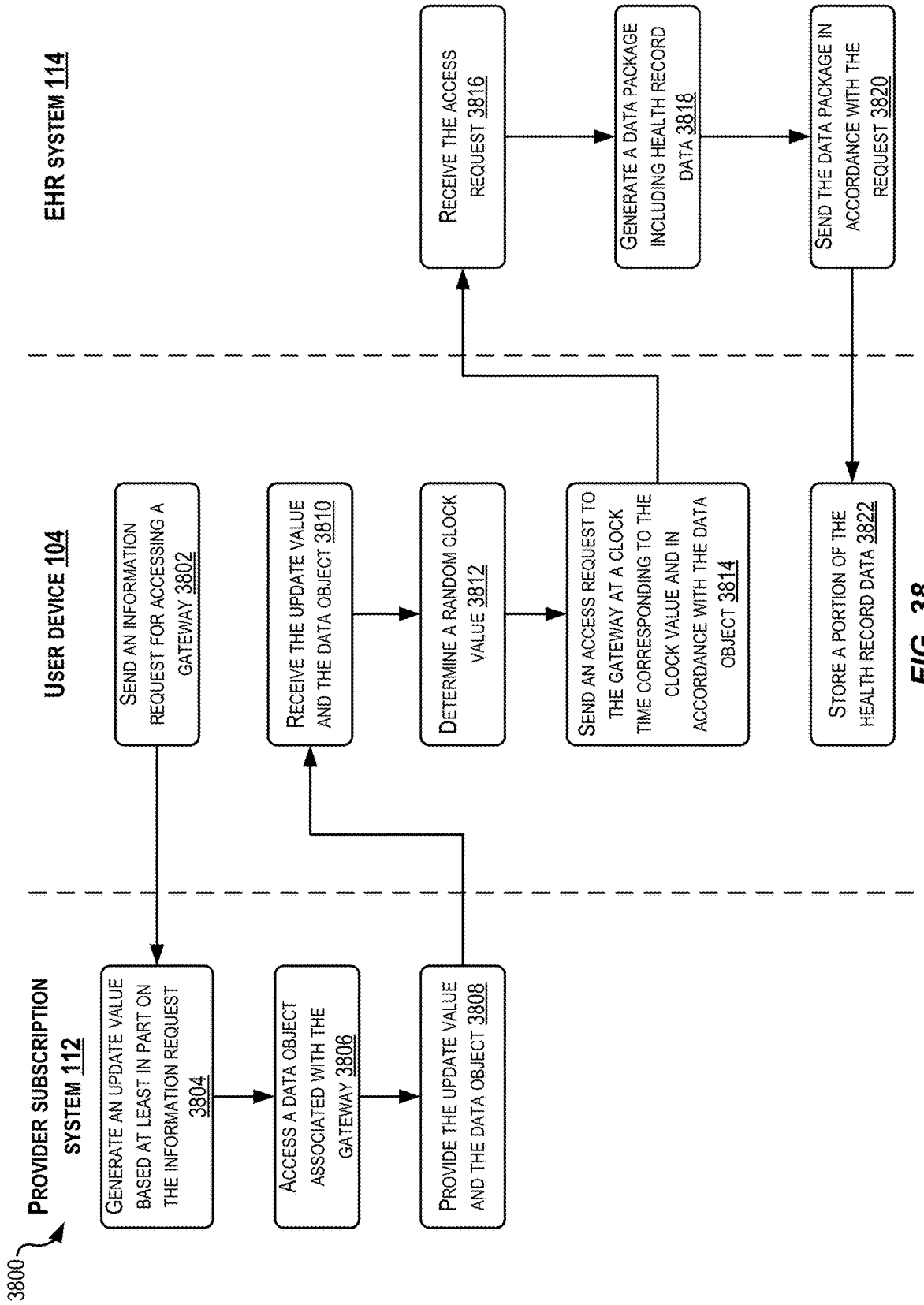
3800
PROVIDER SUBSCRIPTION SYSTEM 112
USER DEVICE 104
EHR SYSTEM 114
GENERATE AN UPDATE VALUE BASED AT LEAST IN PART ON THE INFORMATION REQUEST 3804
ACCESS A DATA OBJECT ASSOCIATED WITH THE GATEWAY 3806
PROVIDE THE UPDATE VALUE AND THE DATA OBJECT 3808
SEND AN INFORMATION REQUEST FOR ACCESSING A GATEWAY 3802
RECEIVE THE UPDATE VALUE AND THE DATA OBJECT 3810
DETERMINE A RANDOM CLOCK VALUE 3812
SEND AN ACCESS REQUEST TO THE GATEWAY AT A CLOCK TIME CORRESPONDING TO THE CLOCK VALUE AND IN ACCORDANCE WITH THE DATA OBJECT 3814
RECEIVE THE ACCESS REQUEST 3816
GENERATE A DATA PACKAGE INCLUDING HEALTH RECORD DATA 3818
SEND THE DATA PACKAGE IN ACCORDANCE WITH THE REQUEST 3820
STORE A PORTION OF THE HEALTH RECORD DATA 3822

FIG. 38

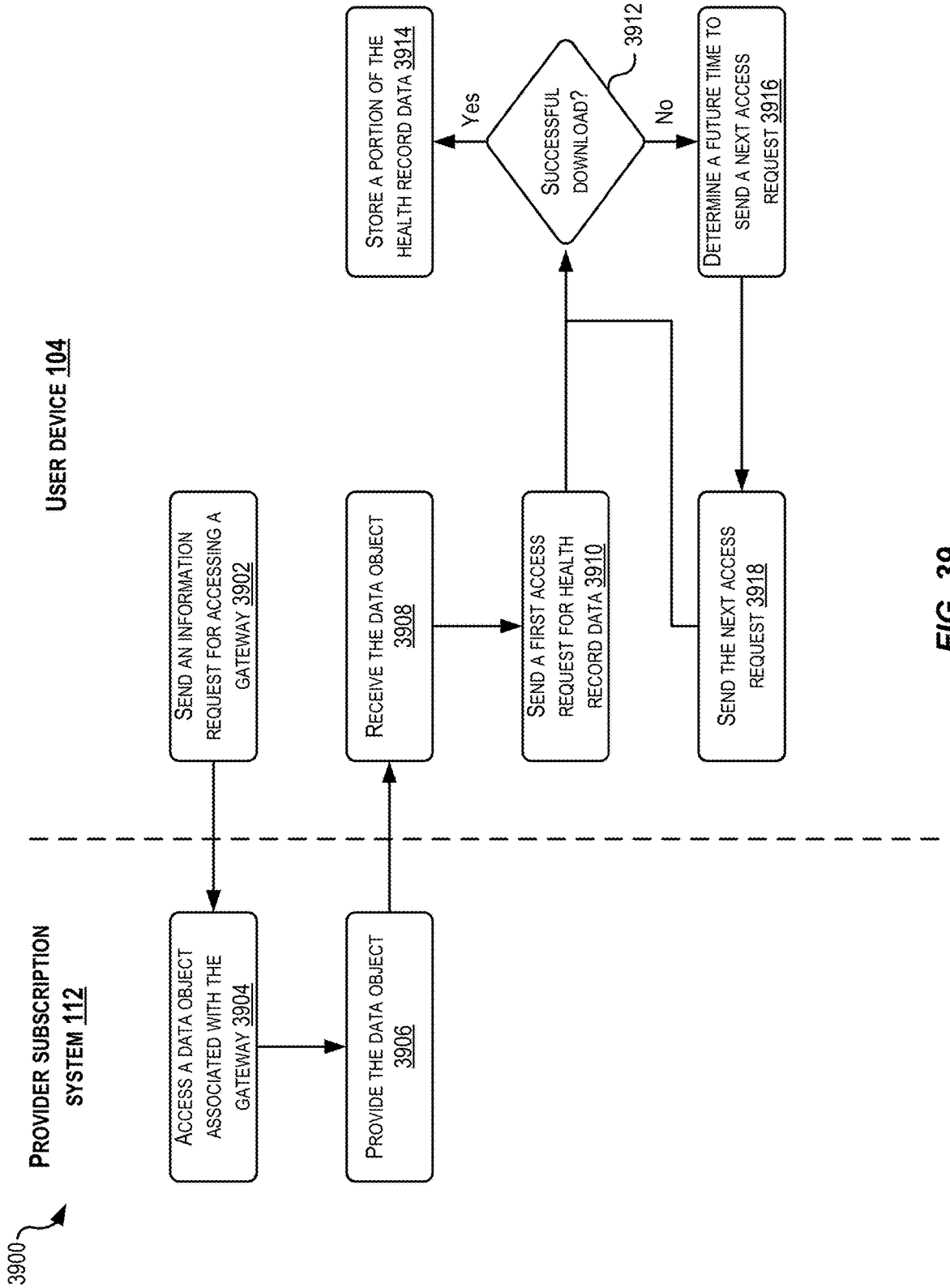
3900
PROVIDER SUBSCRIPTION SYSTEM 112
USER DEVICE 104
ACCESS A DATA OBJECT ASSOCIATED WITH THE GATEWAY 3904
SEND AN INFORMATION REQUEST FOR ACCESSING A GATEWAY 3902
PROVIDE THE DATA OBJECT 3906
RECEIVE THE DATA OBJECT 3908
SEND A FIRST ACCESS REQUEST FOR HEALTH RECORD DATA 3910
SUCCESSFUL DOWNLOAD? 3912
Yes
No
STORE A PORTION OF THE HEALTH RECORD DATA 3914
DETERMINE A FUTURE TIME TO SEND A NEXT ACCESS REQUEST 3916
SEND THE NEXT ACCESS REQUEST 3918

FIG. 39

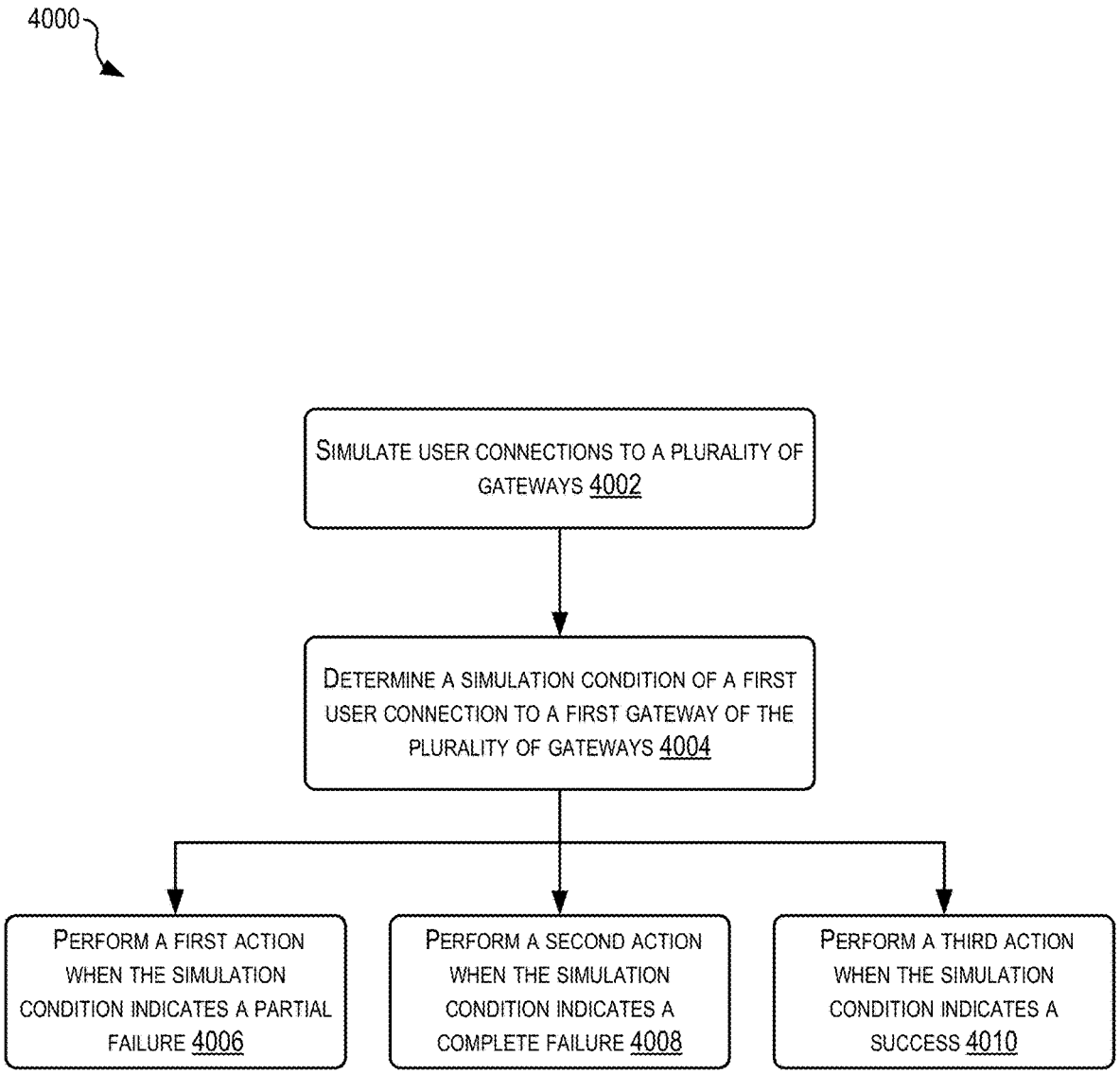
4000
SIMULATE USER CONNECTIONS TO A PLURALITY OF GATEWAYS 4002
DETERMINE A SIMULATION CONDITION OF A FIRST USER CONNECTION TO A FIRST GATEWAY OF THE PLURALITY OF GATEWAYS 4004
PERFORM A FIRST ACTION WHEN THE SIMULATION CONDITION INDICATES A PARTIAL FAILURE 4006
PERFORM A SECOND ACTION WHEN THE SIMULATION CONDITION INDICATES A COMPLETE FAILURE 4008
PERFORM A THIRD ACTION WHEN THE SIMULATION CONDITION INDICATES A SUCCESS 4010

FIG. 40

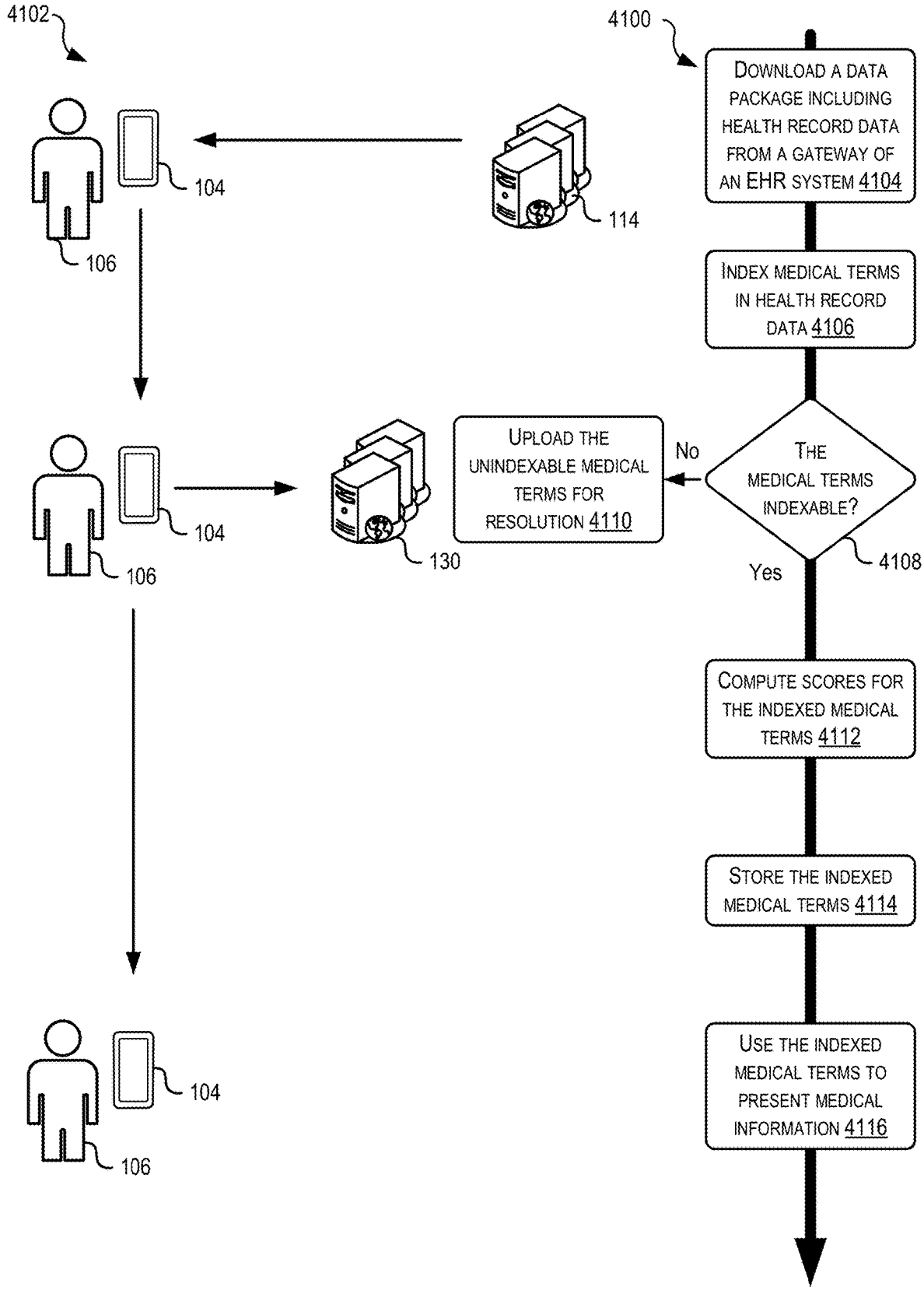
4102
4100
104
106
114
DOWNLOAD A DATA PACKAGE INCLUDING HEALTH RECORD DATA FROM A GATEWAY OF AN EHR SYSTEM 4104
INDEX MEDICAL TERMS IN HEALTH RECORD DATA 4106
THE MEDICAL TERMS INDEXABLE?
4108
No
Yes
UPLOAD THE UNINDEXABLE MEDICAL TERMS FOR RESOLUTION 4110
130
COMPUTE SCORES FOR THE INDEXED MEDICAL TERMS 4112
STORE THE INDEXED MEDICAL TERMS 4114
USE THE INDEXED MEDICAL TERMS TO PRESENT MEDICAL INFORMATION 4116

FIG. 41

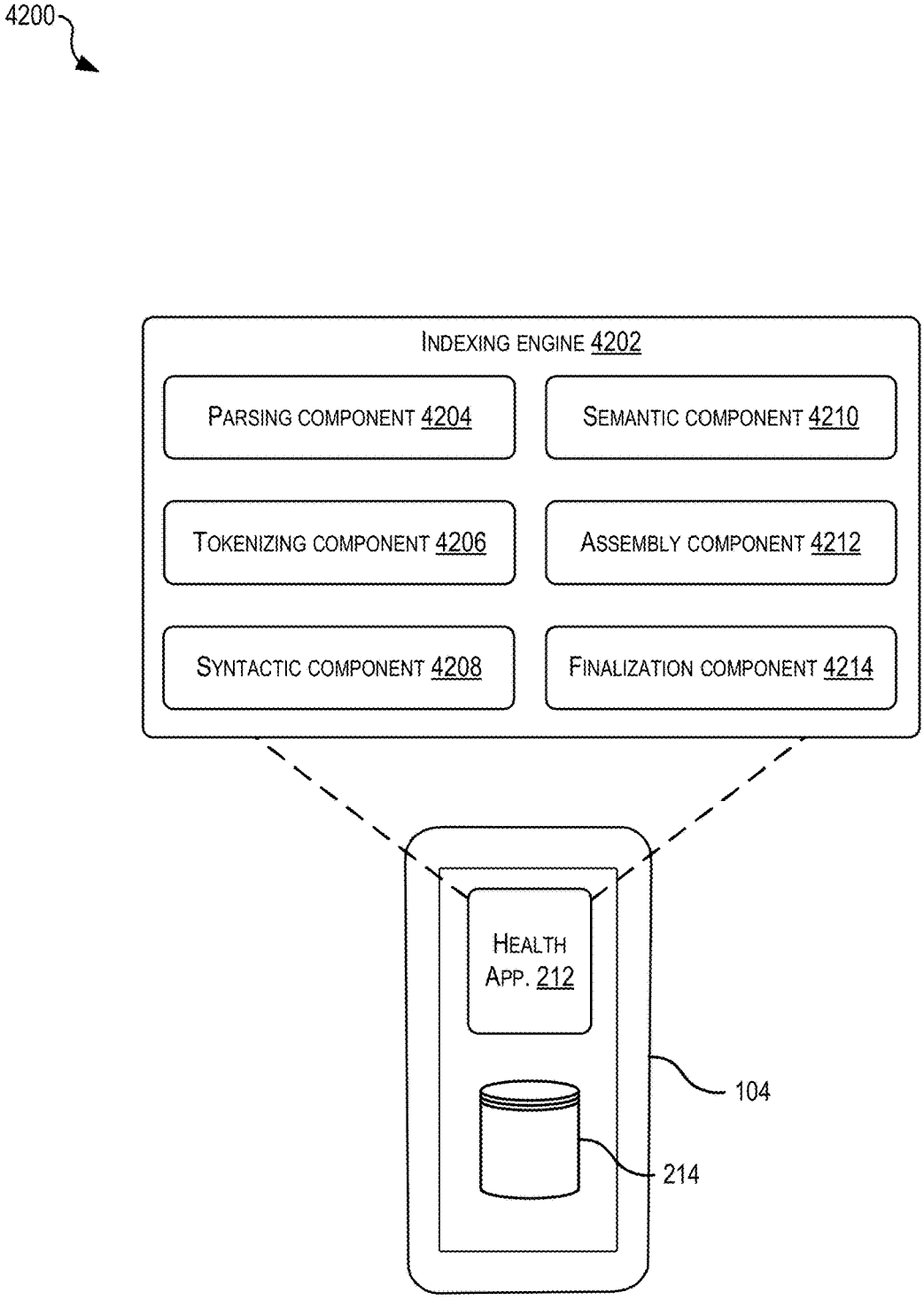
4200
INDEXING ENGINE 4202
PARSING COMPONENT 4204
SEMANTIC COMPONENT 4210
TOKENIZING COMPONENT 4206
ASSEMBLY COMPONENT 4212
SYNTACTIC COMPONENT 4208
FINALIZATION COMPONENT 4214
HEALTH APP. 212
104
214

FIG. 42

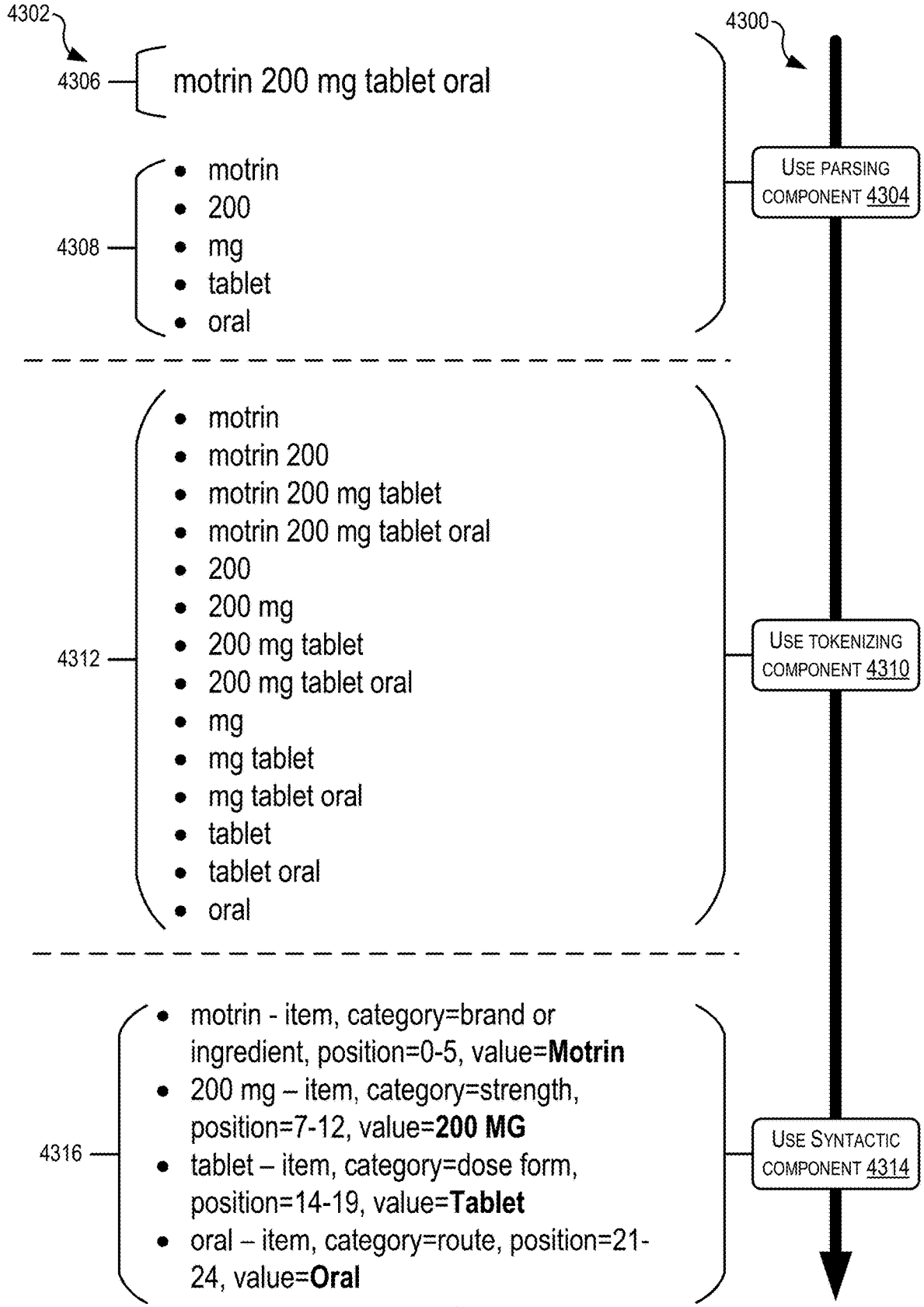
4302
4306
motrin 200 mg tablet oral
4308
motrin
200
mg
tablet
oral
4300
USE PARSING COMPONENT 4304
4312
motrin
motrin 200
motrin 200 mg tablet
motrin 200 mg tablet oral
200
200 mg
200 mg tablet
200 mg tablet oral
mg
mg tablet
mg tablet oral
tablet
tablet oral
oral
USE TOKENIZING COMPONENT 4310
4316
motrin - item, category=brand or ingredient, position=0-5, value=Motrin
200 mg – item, category=strength, position=7-12, value=200 MG
tablet – item, category=dose form, position=14-19, value=Tablet
oral – item, category=route, position=21-24, value=Oral
USE SYNTACTIC COMPONENT 4314

FIG. 43

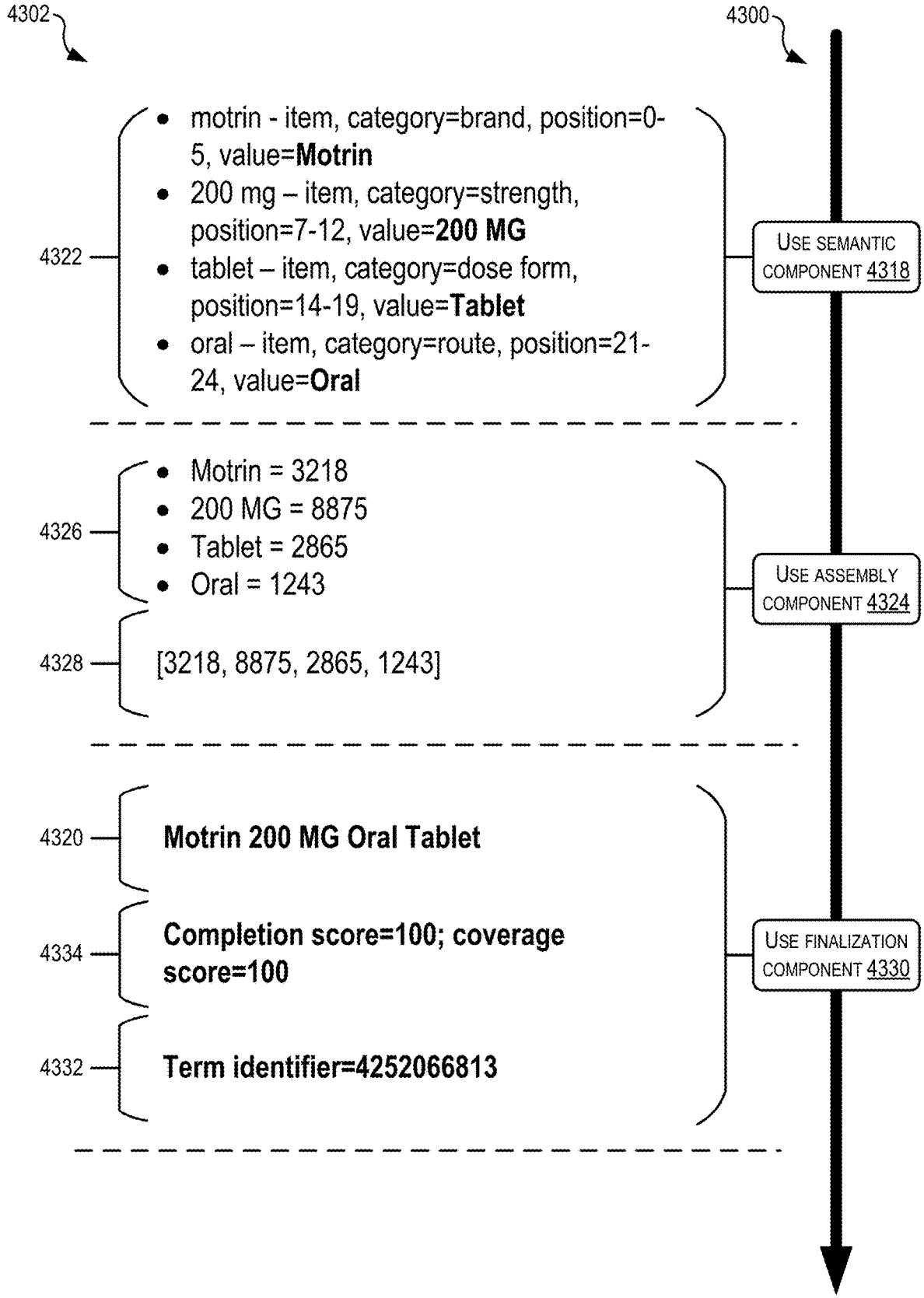
4302
4300
motrin - item, category=brand, position=0-5, value=Motrin
200 mg – item, category=strength, position=7-12, value=200 MG
tablet – item, category=dose form, position=14-19, value=Tablet
oral – item, category=route, position=21-24, value=Oral
4322
USE SEMANTIC COMPONENT 4318
Motrin = 3218
200 MG = 8875
Tablet = 2865
Oral = 1243
4326
[3218, 8875, 2865, 1243]
4328
USE ASSEMBLY COMPONENT 4324
Motrin 200 MG Oral Tablet
4320
Completion score=100; coverage score=100
4334
Term identifier=4252066813
4332
USE FINALIZATION COMPONENT 4330

FIG. 44

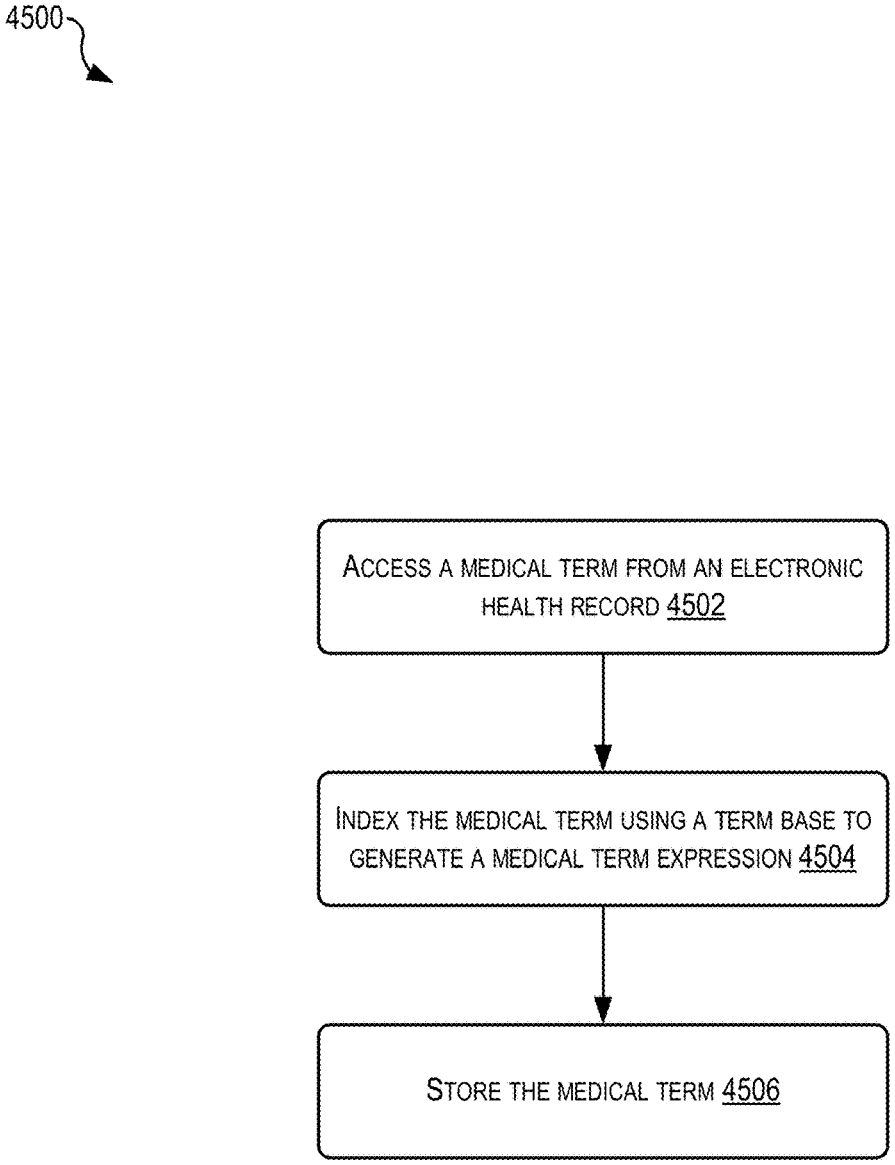
4500
ACCESS A MEDICAL TERM FROM AN ELECTRONIC HEALTH RECORD 4502
INDEX THE MEDICAL TERM USING A TERM BASE TO GENERATE A MEDICAL TERM EXPRESSION 4504
STORE THE MEDICAL TERM 4506

FIG. 45

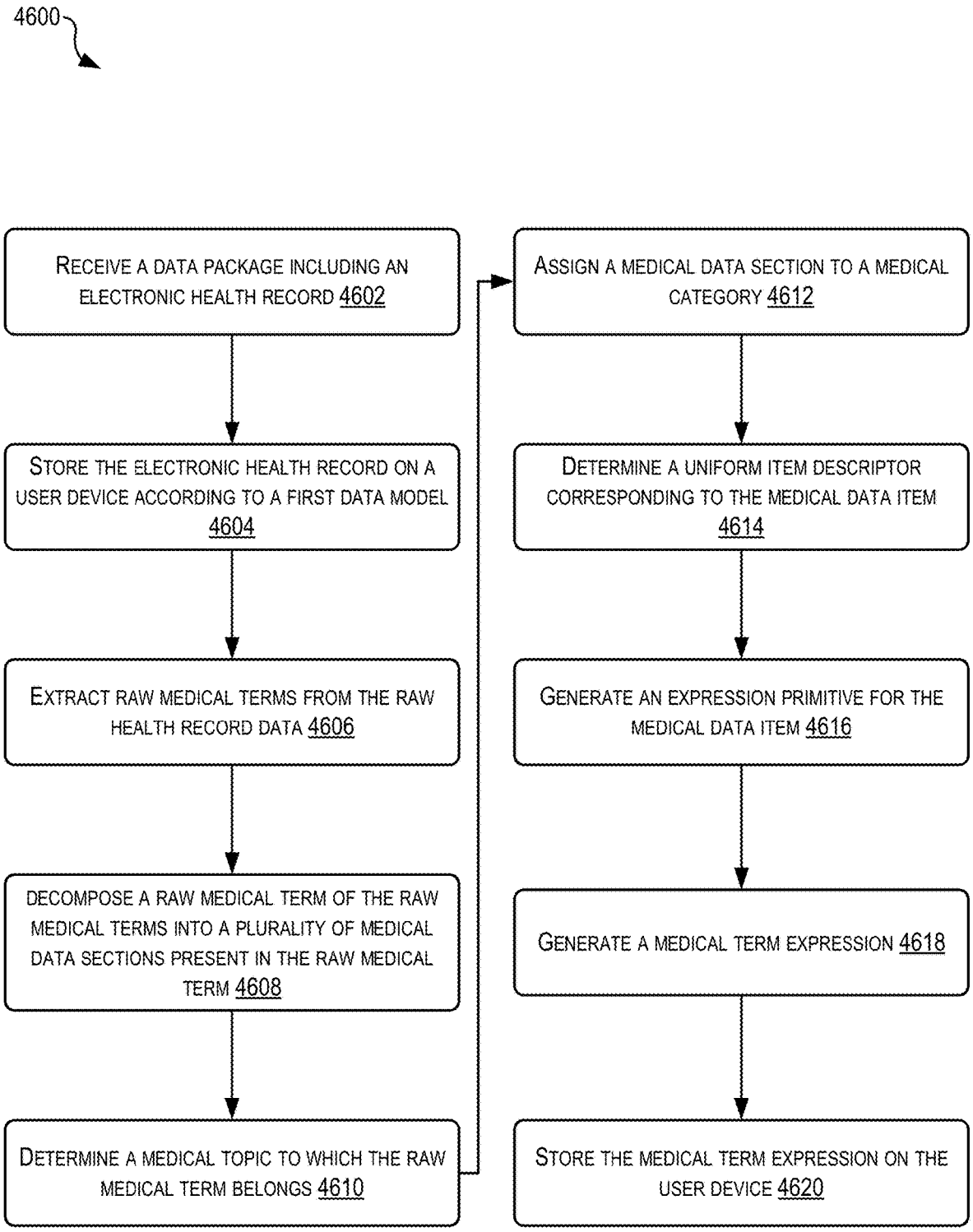
4600
RECEIVE A DATA PACKAGE INCLUDING AN ELECTRONIC HEALTH RECORD 4602
STORE THE ELECTRONIC HEALTH RECORD ON A USER DEVICE ACCORDING TO A FIRST DATA MODEL 4604
EXTRACT RAW MEDICAL TERMS FROM THE RAW HEALTH RECORD DATA 4606
DECOMPOSE A RAW MEDICAL TERM OF THE RAW MEDICAL TERMS INTO A PLURALITY OF MEDICAL DATA SECTIONS PRESENT IN THE RAW MEDICAL TERM 4608
DETERMINE A MEDICAL TOPIC TO WHICH THE RAW MEDICAL TERM BELONGS 4610
ASSIGN A MEDICAL DATA SECTION TO A MEDICAL CATEGORY 4612
DETERMINE A UNIFORM ITEM DESCRIPTOR CORRESPONDING TO THE MEDICAL DATA ITEM 4614
GENERATE AN EXPRESSION PRIMITIVE FOR THE MEDICAL DATA ITEM 4616
GENERATE A MEDICAL TERM EXPRESSION 4618
STORE THE MEDICAL TERM EXPRESSION ON THE USER DEVICE 4620

FIG. 46

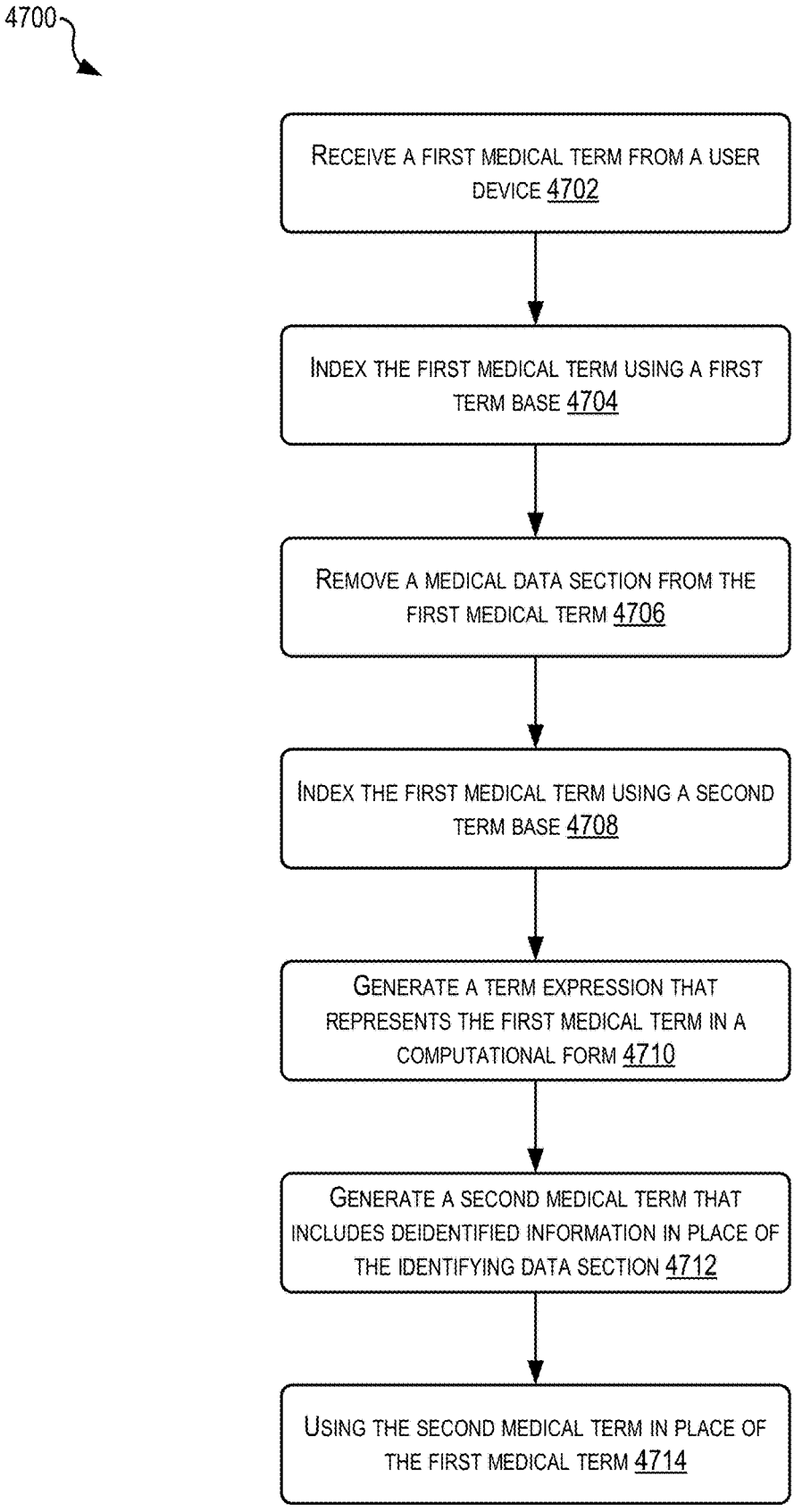
4700
RECEIVE A FIRST MEDICAL TERM FROM A USER DEVICE 4702
INDEX THE FIRST MEDICAL TERM USING A FIRST TERM BASE 4704
REMOVE A MEDICAL DATA SECTION FROM THE FIRST MEDICAL TERM 4706
INDEX THE FIRST MEDICAL TERM USING A SECOND TERM BASE 4708
GENERATE A TERM EXPRESSION THAT REPRESENTS THE FIRST MEDICAL TERM IN A COMPUTATIONAL FORM 4710
GENERATE A SECOND MEDICAL TERM THAT INCLUDES DEIDENTIFIED INFORMATION IN PLACE OF THE IDENTIFYING DATA SECTION 4712
USING THE SECOND MEDICAL TERM IN PLACE OF THE FIRST MEDICAL TERM 4714

FIG. 47

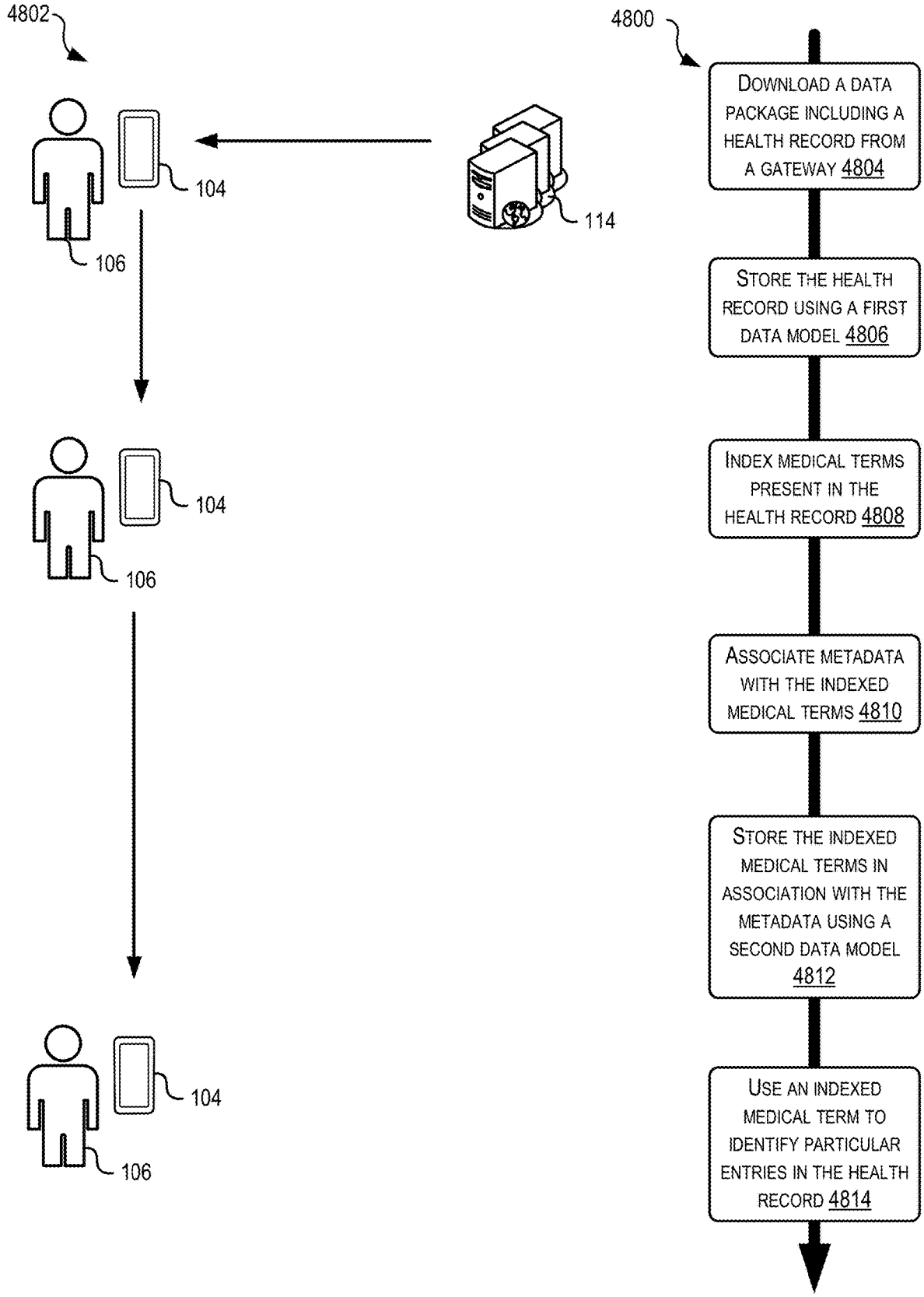
4802
4800
104
106
114
DOWNLOAD A DATA PACKAGE INCLUDING A HEALTH RECORD FROM A GATEWAY 4804
STORE THE HEALTH RECORD USING A FIRST DATA MODEL 4806
INDEX MEDICAL TERMS PRESENT IN THE HEALTH RECORD 4808
ASSOCIATE METADATA WITH THE INDEXED MEDICAL TERMS 4810
STORE THE INDEXED MEDICAL TERMS IN ASSOCIATION WITH THE METADATA USING A SECOND DATA MODEL 4812
USE AN INDEXED MEDICAL TERM TO IDENTIFY PARTICULAR ENTRIES IN THE HEALTH RECORD 4814

FIG. 48

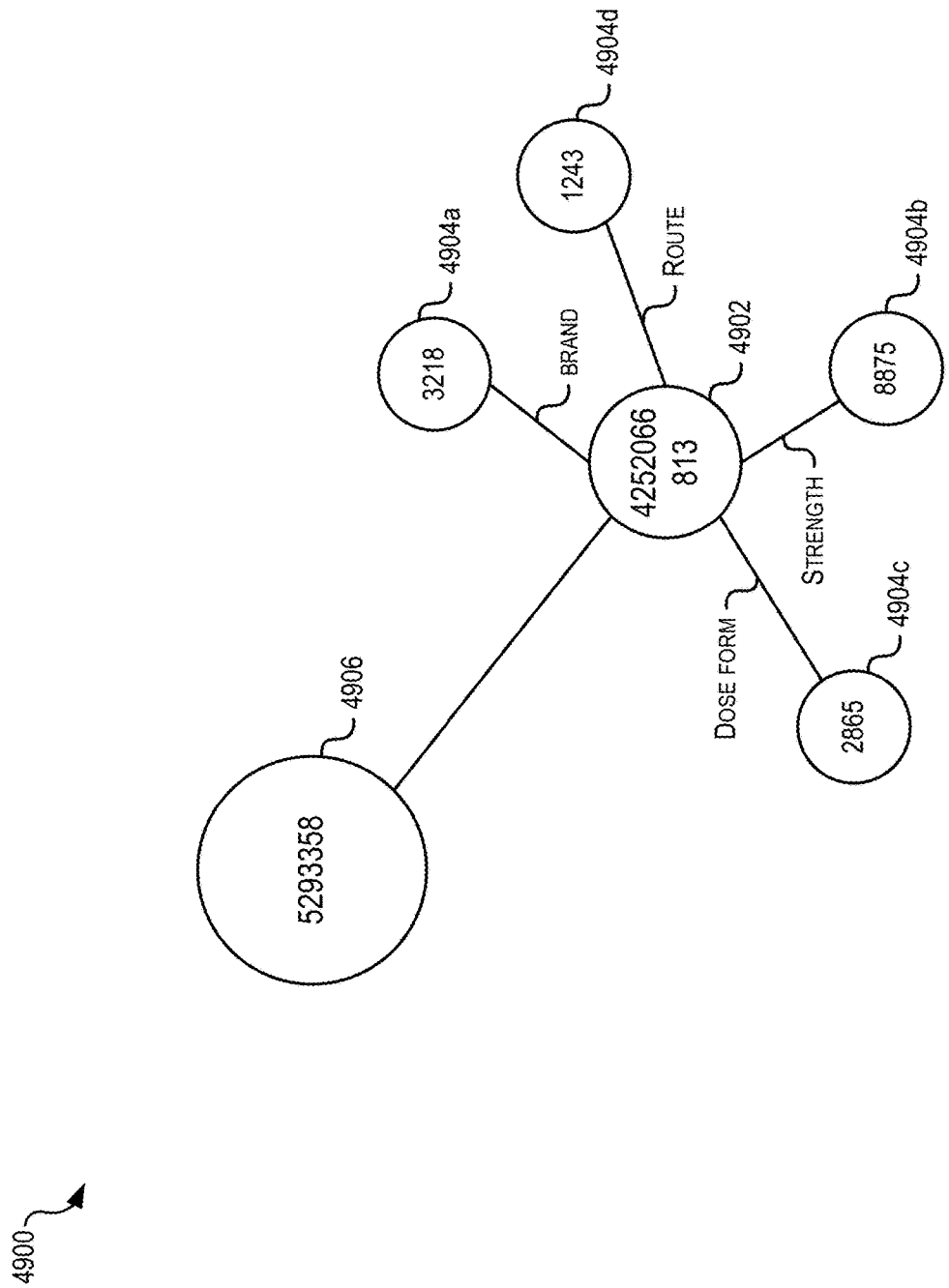
4900
5293358
4906
4252066
813
4902
3218
4904a
BRAND
1243
4904d
ROUTE
8875
4904b
STRENGTH
2865
4904c
DOSE FORM

FIG. 49

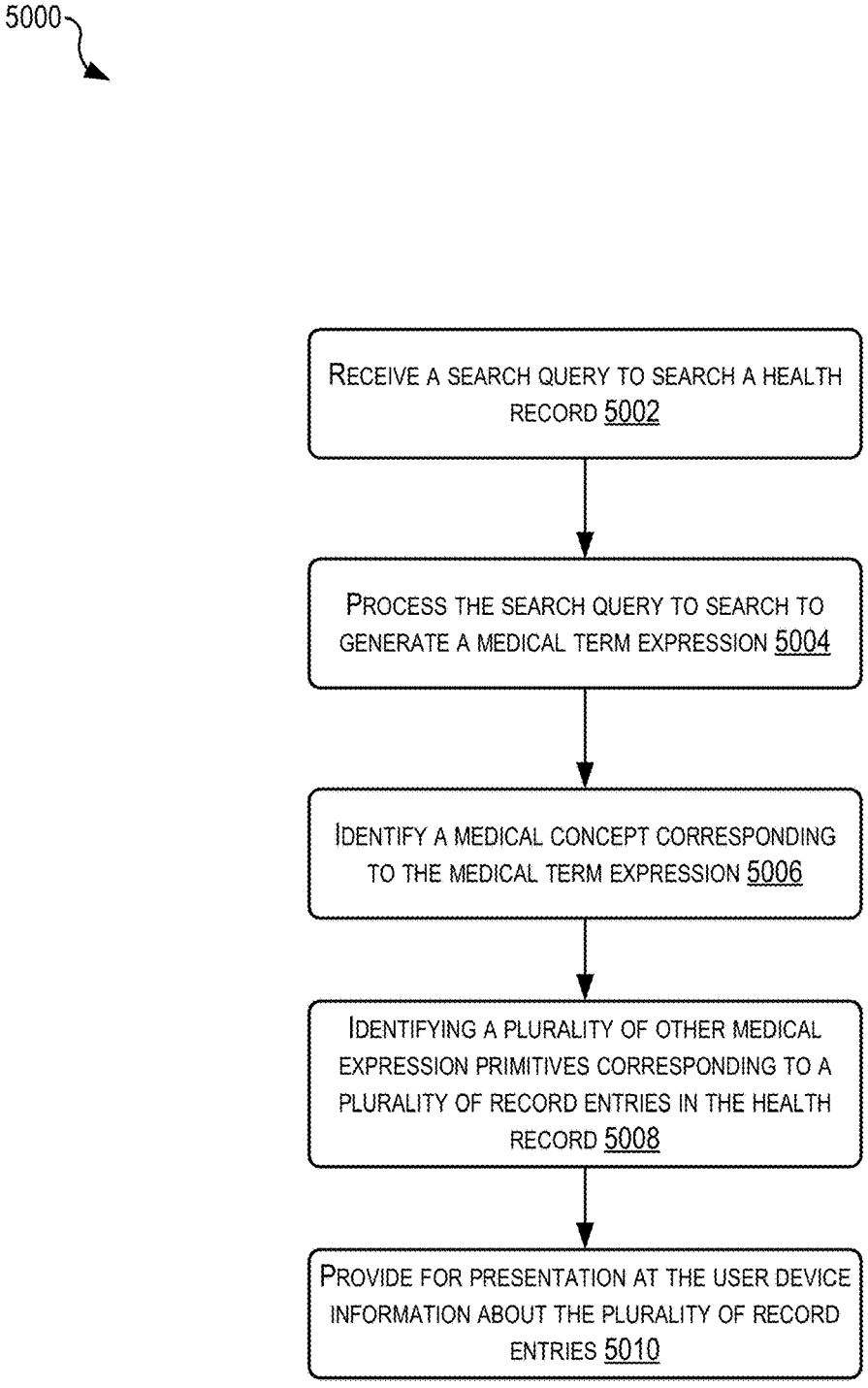
5000
RECEIVE A SEARCH QUERY TO SEARCH A HEALTH RECORD 5002
PROCESS THE SEARCH QUERY TO SEARCH TO GENERATE A MEDICAL TERM EXPRESSION 5004
IDENTIFY A MEDICAL CONCEPT CORRESPONDING TO THE MEDICAL TERM EXPRESSION 5006
IDENTIFYING A PLURALITY OF OTHER MEDICAL EXPRESSION PRIMITIVES CORRESPONDING TO A PLURALITY OF RECORD ENTRIES IN THE HEALTH RECORD 5008
PROVIDE FOR PRESENTATION AT THE USER DEVICE INFORMATION ABOUT THE PLURALITY OF RECORD ENTRIES 5010

FIG. 50

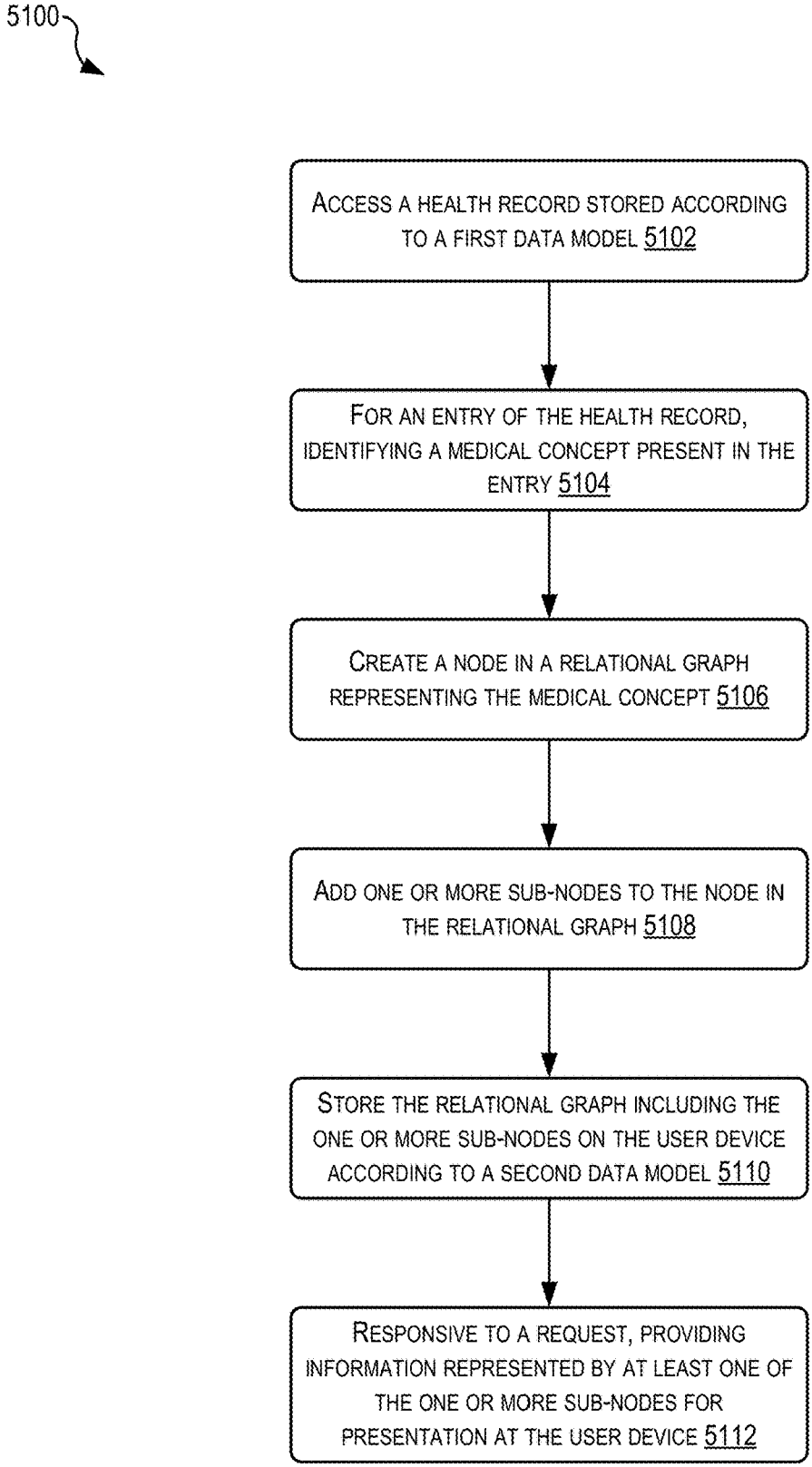
5100
ACCESS A HEALTH RECORD STORED ACCORDING TO A FIRST DATA MODEL 5102
FOR AN ENTRY OF THE HEALTH RECORD, IDENTIFYING A MEDICAL CONCEPT PRESENT IN THE ENTRY 5104
CREATE A NODE IN A RELATIONAL GRAPH REPRESENTING THE MEDICAL CONCEPT 5106
ADD ONE OR MORE SUB-NODES TO THE NODE IN THE RELATIONAL GRAPH 5108
STORE THE RELATIONAL GRAPH INCLUDING THE ONE OR MORE SUB-NODES ON THE USER DEVICE ACCORDING TO A SECOND DATA MODEL 5110
RESPONSIVE TO A REQUEST, PROVIDING INFORMATION REPRESENTED BY AT LEAST ONE OF THE ONE OR MORE SUB-NODES FOR PRESENTATION AT THE USER DEVICE 5112

FIG. 51

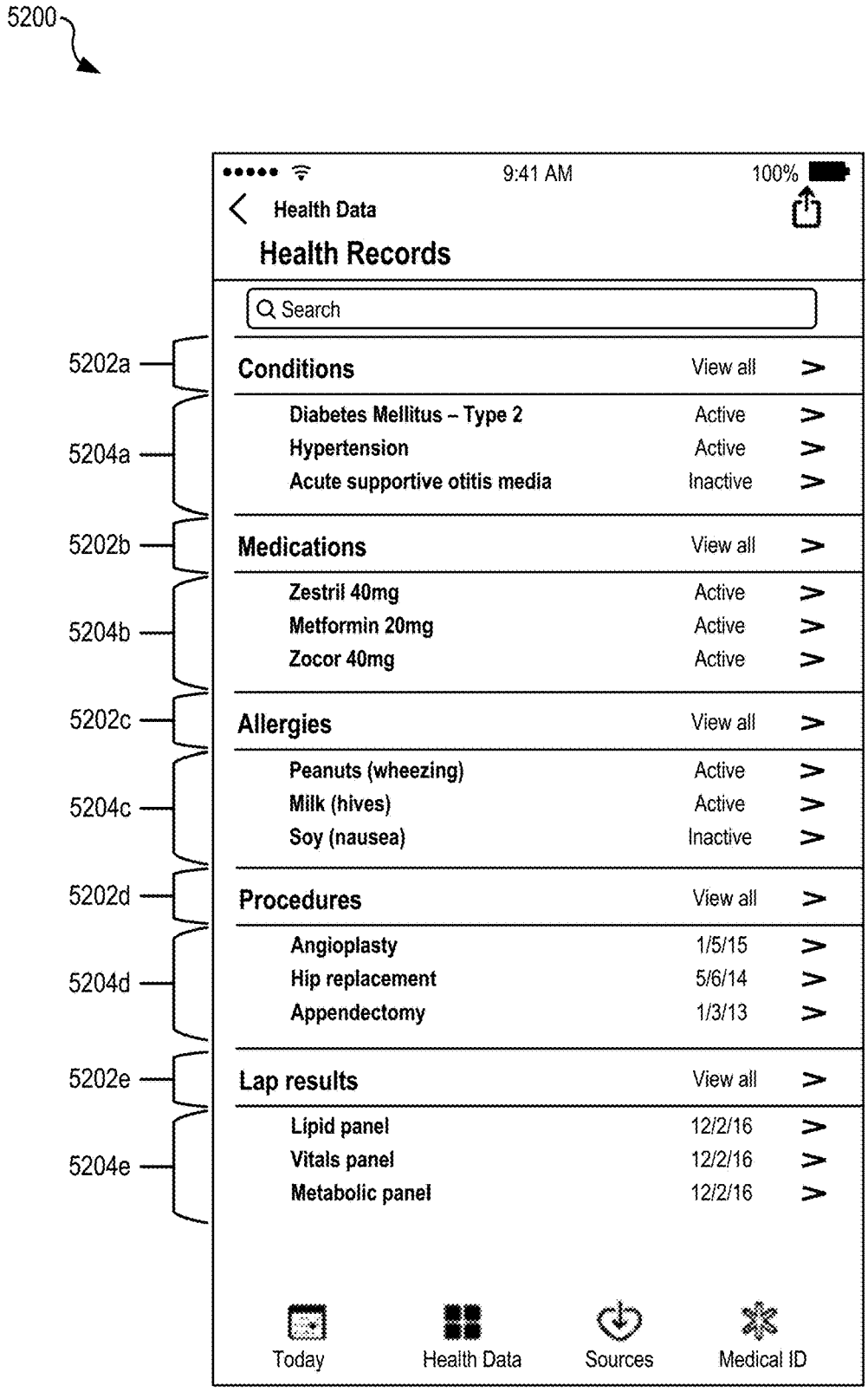
5200
9:41 AM
100%
Health Data
Health Records
Search
5202a
Conditions
View all
5204a
Diabetes Mellitus – Type 2
Active
Hypertension
Active
Acute supportive otitis media
Inactive
5202b
Medications
View all
5204b
Zestril 40mg
Active
Metformin 20mg
Active
Zocor 40mg
Active
5202c
Allergies
View all
5204c
Peanuts (wheezing)
Active
Milk (hives)
Active
Soy (nausea)
Inactive
5202d
Procedures
View all
5204d
Angioplasty
1/5/15
Hip replacement
5/6/14
Appendectomy
1/3/13
5202e
Lap results
View all
5204e
Lipid panel
12/2/16
Vitals panel
12/2/16
Metabolic panel
12/2/16
Today
Health Data
Sources
Medical ID

FIG. 52

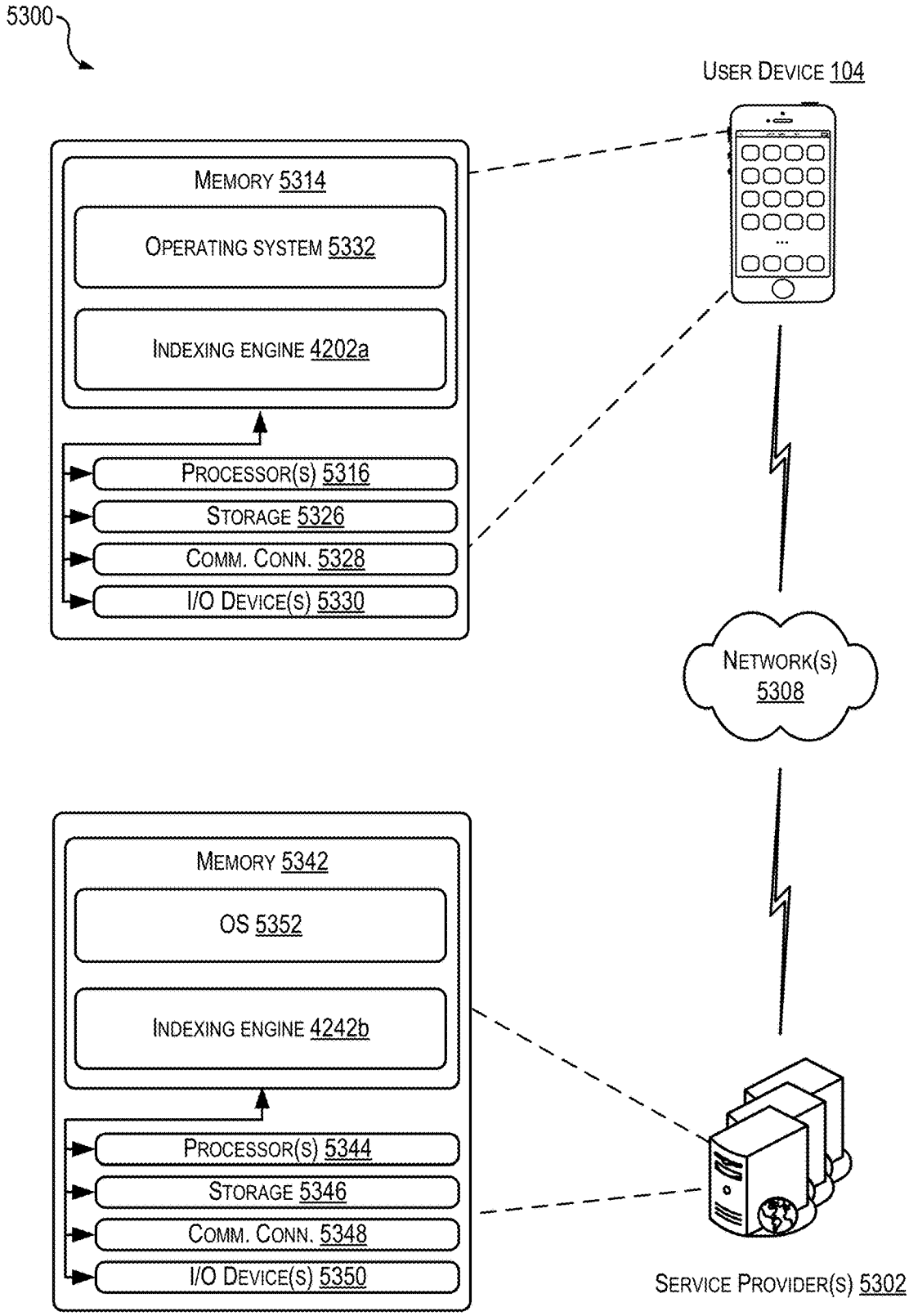
5300
USER DEVICE 104
MEMORY 5314
OPERATING SYSTEM 5332
INDEXING ENGINE 4202a
PROCESSOR(S) 5316
STORAGE 5326
COMM. CONN. 5328
I/O DEVICE(S) 5330
NETWORK(S) 5308
MEMORY 5342
OS 5352
INDEXING ENGINE 4242b
PROCESSOR(S) 5344
STORAGE 5346
COMM. CONN. 5348
I/O DEVICE(S) 5350
SERVICE PROVIDER(S) 5302

FIG. 53

TECHNIQUES FOR ANONYMIZED SEARCHING OF MEDICAL PROVIDERS

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a continuation of U.S. application Ser. No. 15/947,478, filed Apr. 6, 2018, entitled "Techniques for Anonymized Searching of Medical Providers," which claims the benefit of and priority to U.S. Provisional Application No. 62/566,051, filed Sep. 29, 2017, entitled "Techniques for Anonymized Searching of Medical Providers," The disclosure of these applications are incorporated by reference herein in their entirety.

This application is related to co-pending U.S. patent application Ser. No. 15/849,310, filed Dec. 20, 2017, entitled "On-Device Searching Using Medical Term Expressions," which claims the benefit of and priority to U.S. Provisional Patent Application No. 62/565,956, filed Sep. 29, 2017, entitled "On-Device Searching Using Medical Term Expressions" and is related to co-pending U.S. patent application Ser. No. 16/019,497, filed Jun. 26, 2018, entitled "Normalization of Medical Terms" and co-pending U.S. patent application Ser. No. 16/019,501, filed Jun. 26, 2018, entitled "Index-Based Deidentification" both which claim the benefit of and priority to U.S. Provisional Patent Application No. 62/565,847, filed Sep. 29, 2017, entitled "Normalization of Medical Terms" and is related to co-pending U.S. patent application Ser. No. 15/884,023, filed Jan. 30, 2018, entitled "Techniques for Managing Access of User Devices to Third-Party Resources," which claims the benefit of and priority to U.S. Provisional Patent Application No. 62/566,014, filed Sep. 29, 2017, entitled "Techniques for Managing Access of User Devices to Third-Party Resources" and is related to co-pending U.S. patent application Ser. No. 15/884,115, filed Jan. 30, 2018, entitled "Techniques for Building Medical Provider Databases," which claims the benefit of and priority to U.S. Provisional Patent Application No. 62/566,104, filed Sep. 29, 2017, entitled, "Techniques for Building Medical Provider Databases."

BACKGROUND

Users typically visit more than one health institution to obtain medical treatment. For example, a user may periodically visit a neighborhood clinic for annual physical evaluations and for minor medical procedures. An electronic health record (EHR) is a computer-stored and transferrable copy of a user's physical health record. The neighborhood clinic may maintain an instance of the user's electronic health record (e.g., using an EHR system, sometimes referred to as an electronic medical record (EMR) system). When the user visits, a medical professional may update the electronic health record. However, different instances of the user's electronic health record may be maintained by other health institutions that are unaffiliated with the neighborhood clinic. For example, the user may have visited a surgical center for a surgery, been transported to an emergency room in connection with an accident, or may have visited a different clinic while on vacation in a different city. Each of the surgical center, the emergency room, and the different clinic, may have created an instance of the user's electronic health record, which may be maintained using different EHR systems. The EHR systems may provide patient portals for accessing health records on their systems. Because these portals are built and maintained by different organizations, accessing each by the user may require a unique set of user credentials. And once the user logs in to a particular portal, she is still limited by what portion of her electronic health record will be available for viewing. Existing computer systems may be able to maintain a single connection to a single EHR system, but challenges may arise when these systems attempt to programmatically maintain multiple connections across multiple EHR systems. Moreover, because different medical professionals contribute to the instances of the electronic health record, data inconsistencies may exist between electronic health records sourced from different EHR systems. Conventional data rectification techniques may prove insufficient to resolve these types of data inconsistencies.

BRIEF SUMMARY

A system of one or more computers can be configured to perform particular operations or actions by virtue of having software, firmware, hardware, or a combination of them installed on the system that in operation causes or cause the system to perform the actions. One or more computer programs can be configured to perform particular operations or actions by virtue of including instructions that, when executed by data processing apparatus, cause the apparatus to perform the actions. One general aspect includes a system, including: a memory configured to store computer-executable instructions and a processor in communication with the memory and configured to execute the computer-executable instructions to at least generate a medical entity batch including a brand entity set, location entity set, and a gateway entity set, by at least selecting a first location entity associated with a first geographic location, beginning, based at least in part on the first geographic location, an outward expanding geographic search for other entities, and ceasing the outward expanding geographic search when a threshold number of entities has been identified for each of the brand entity set, the location entity set, and the gateway entity set. The processor is also configured to assign a batch identifier to the medical entity batch, individual entities in the medical entity batch being associated with respective entity identifiers. The processor is also configured to receive a search query from a user device, the search query including one or more search terms. The system also includes provide search results to the user device based at least in part on the one or more search terms, the search results including a list of medical entities. The processor is also configured to receive a request from the user device for information about a particular medical entity from the list of medical entities, the particular medical entity belonging to the medical entity batch, and the request including the batch identifier and a particular entity identifier identifying the particular medical entity. The processor is also configured to provide, to the user device, the information about the particular medical entity together with other information about other entities in the medical entity batch. Other examples of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

Implementations may include one or more of the following features. The processor may be further configured to execute the computer-executable instructions to at least receive a second request from the user device for additional information about the particular medical entity, the second request including the batch identifier and the particular entity identifier. The system where at least one gateway entity of the gateway entity set is associated with more than

one location entity of the location entity set. The system where: the system further includes a provider database configured to store the information about the medical entities in the medical entity batch. The processor may further be configured to execute the computer-executable instructions to at least, after assigning the batch identifier, store information about the medical entity batch in association with the batch identifier in the provider database. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

One general aspect includes a computer-implemented method, including: generating an entity batch including a plurality of medical entities. The computer-implemented method also includes assigning a batch identifier to the entity batch, individual medical entities in the entity batch being associated with respective entity identifiers. The computer-implemented method also includes receiving a search query from a user device, the search query including one or more search terms. The computer-implemented method also includes providing search results to the user device based at least in part on the one or more search terms, the search results including a list of medical entities. The computer-implemented method also includes receiving a request from the user device for information about a particular medical entity from the list of medical entities, the particular medical entity belonging to the entity batch, and the request including the batch identifier and a particular entity identifier identifying the particular medical entity. The computer-implemented method also includes providing, to the user device, the information about the particular medical entity together with other information about other medical entities in the entity batch. Other examples of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

Implementations may include one or more of the following features. The computer-implemented method where the entity batch includes a brand entity set, a location entity set, and a gateway entity set. The computer-implemented method where at least one location entity of the location entity set is associated with more than one gateway entity of the gateway entity set. The computer-implemented method where generating the entity batch includes: selecting a first location entity associated with a first geographic location. The computer-implemented method may also include beginning, based at least in part on the first geographic location, an outward expanding geographic search for other entities. The computer-implemented method may also include ceasing the outward expanding geographic search when a threshold number of entities has been identified for each of the brand entity set, the location entity set, and the gateway entity set. The computer-implemented method where generating the entity batch is based at least in part on generating a plurality of other entity batches. The computer-implemented method where generating the plurality of other entity batches and the entity batch includes: converting each entity identifier of each medical entity to an integer value in a range between one and a predefined number corresponding to a number of slots in each entity batch. The computer-implemented method may also include assigning each medical entity to a respective entity batch based at least in part on the respective integer value, the respective integer value being equal to a respective batch identifier. The computer-implemented method where providing the information about the particular medical entity together with the other information about the other medical entities in the entity batch obfuscates an identity of the particular medical entity. The computer-implemented method where: the request is a first request. The computer-implemented method may also include the method further includes receiving a second request from the user device for the other information about the particular medical entity, the second request including the batch identifier and the particular entity identifier. The computer-implemented method further including enabling the user device to establish a connection with a gateway entity associated with the particular medical entity. The computer-implemented method where the information about the particular medical entity includes configuration information associated with the gateway entity, the configuration information useable by the user device to make one or more predefined method calls to the gateway entity. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

One general aspect includes a user device, including: a memory configured to store computer-executable instructions and a processor in communication with the memory and configured to execute the computer-executable instructions to at least provide a search query to a server, the search query including one or more search terms. The processor is also configured to receive, from the server, search results including a minimum number of medical entities, the search results selected based at least in part on the one or more search terms, each medical entity of the minimum number of medical entities being associated with an entity identifier. The processor is also configured to receive user selection of a first medical entity from the minimum number of medical entities. The processor is also configured to store a first entity identifier associated the first medical entity in association with other entity identifiers associated with other medical entities from the minimum number of medical entities. The processor is also configured to provide a request to the server for information about the first medical entity, the request including the first entity identifier and the other entity identifiers. The processor is also configured to receive, from the server and in response to providing the request, the information about the first medical entity together with other information about the other medical entities. Other examples of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

Implementations may include one or more of the following features. The user device where receive the information about the first medical entity together with the other information about the other medical entities obfuscates, from the server, an identity of the first medical entity as the medical entity that was subject to the user selection. The user device where the processor is further configured to execute the computer-executable instructions to at least establish a connection with a gateway entity associated with the first medical entity. The user device where the information about the first medical entity includes configuration information associated with the gateway entity, the configuration information useable by the user device to make one or more predefined method calls to the gateway entity to establish the connection with the gateway entity. The processor is also configured to store the first entity identifier associated the first medical entity in association with the other entity identifiers associated with the other medical entities at least during a period of time when the connection with the gateway entity exists. Implementations of the described

techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a block diagram and a flowchart for enabling storage and retrieval of electronic health records on user devices, according to at least one example.

FIG. **2** illustrates a block diagram showing an example architecture or system for enabling storage and retrieval of electronic health records on user devices, according to at least one example.

FIG. **3** illustrates a block diagram and a flow chart for onboarding medical provider entities on to a system that enables sharing of electronic health records between user devices and electronic health record systems, according to at least one example.

FIG. **4** illustrates a block diagram showing a data structure for storing relationships between entities of an organization entity, according to at least one example.

FIGS. **5-17** illustrate example views of a user interface for onboarding provider entities on to a system that enables sharing of electronic health records between user devices and gateways of electronic health record system, according to at least one example.

FIG. **18** illustrates an example flow chart showing a process for managing user authentication as part of establishing connections to medical provider entities to download electronic health records of the electronic health record systems, according to at least one example.

FIG. **19** illustrates an example flow chart showing a process for managing entity relationships, according to at least one example.

FIG. **20** illustrates an example flow chart showing a process for enabling anonymized user searching of medical provider entities, according to at least one example.

FIGS. **21-33** illustrate a series of processes, decision points, and user interface (UI) views relating to a user operating a health application of a user device to connect to a gateway of an electronic health record system for downloading health record data, according to various examples

FIG. **34** illustrates a diagram depicting a geographic approach for constructing a batch of medical provider entities for enabling anonymized user searching of medical provider entities, according to at least one example.

FIG. **35** illustrates an example flow chart showing a process for enabling anonymized user searching of medical provider entities, according to at least one example.

FIG. **36** illustrates an example flow chart showing a process for enabling anonymized user searching of medical provider entities, according to at least one example.

FIG. **37** illustrates a block diagram depicting a server-based approach for managing user device access to a plurality of electronic health record systems, according to at least one example.

FIG. **38** illustrates an example flow chart showing a process for a server-based approach for managing access of a user device to a gateway of an electronic health record system, according to at least one example.

FIG. **39** illustrates an example flow chart showing a process for a user-device based approach for managing access to a gateway of an electronic health record system, according to at least one example.

FIG. **40** illustrates an example flow chart showing a process for simulating user connections to gateways of electronic health record systems, according to at least one example.

FIG. **41** illustrates a block diagram and a flow chart for indexing medical terms from an electronic health record, according to at least one example.

FIG. **42** illustrates a block diagram depicting a user device useable for indexing medical terms from an electronic health record, according to at least one example.

FIG. **43** illustrates a flow chart and associated depictions for indexing medical terms from an electronic health record, according to at least one example.

FIG. **44** illustrates a continuation of the flow chart from FIG. **43**, according to at least one example.

FIG. **45** illustrates an example flow chart showing a process for indexing medical terms from an electronic health record, according to at least one example.

FIG. **46** illustrates an example flow chart showing a process for indexing medical terms from an electronic health record, according to at least one example.

FIG. **47** illustrates an example flow chart showing a process for removing personally identifying information using an indexing engine, according to at least one example.

FIG. **48** illustrates a block diagram and a flow chart for enhancing a health record using indexed medical terms, according to at least one example.

FIG. **49** illustrates an example diagram depicting a relational graph relating to a medical term expression, according to at least one example.

FIG. **50** illustrates an example flow chart showing a process for searching an electronic health record using a medical term expression, according to at least one example.

FIG. **51** illustrates an example flow chart showing a process for searching a relational graph representing a medical concept, according to at least one example.

FIG. **52** illustrates an example user interface view illustrating a portion of an electronic health record organized according to medical concepts, according to at least one example.

FIG. **53** illustrates a simplified block diagram depicting an example architecture for implementing the techniques described herein, according to at least one example.

DETAILED DESCRIPTION

In the following description, various examples will be described. For purposes of explanation, specific configurations and details are set forth in order to provide a thorough understanding of the examples. However, it will also be apparent to one skilled in the art that the examples may be practiced without the specific details. Furthermore, well-known features may be omitted or simplified in order not to obscure the example being described.

Examples of the present disclosure are directed to, among other things, methods, systems, devices, and computer-readable media for obtaining electronic health records from various disparate sources, processing the electronic health records to enable efficient storage and retrieval, and presenting medical information from the electronic health records in a uniform manner using a health application of a user device. Users to whom the electronic health records belong typically visit different medical providers as part of obtaining treatment. These medical providers may be part of the same provider organization (e.g., a clinic and a hospital owned by the same entity) or may be part of different organizations (e.g., a dialysis clinic owned by a first entity and an imaging center owned by a second entity). Each of these medical providers may maintain a portion of a particular user's electronic health record using EHR systems.

Some medical providers may provide web portals (e.g., patient portals) that allow users to view and/or otherwise interact with their respective electronic health records. However, because the medical industry is made up of many different organizations and because users tend to obtain care from different organizations, it is very unlikely that a single web portal will have a complete electronic health record for every user. Instead, users may have to access multiple web portals; however, some medical providers may not even offer web portal capabilities. Because of this, users face challenges as they try to view a complete picture of their medical history.

The EHR systems that hosts the web portals may be configured differently from one another. For example, data storage formats, user and administrator functionality, and coding schemas may be unique to each. A system described herein enables individual, ongoing data pipelines to be established with each of these disparate sources. Once a pipeline is connected, the system described provides a platform for normalizing the data storage formats, user and administrator functionality, and coding schemas from these disparate sources. Thus, once each pipeline has been connected, the data may be stored on a user device in a uniform format, with a predefined set of user functionality, and according to a single coding schema. Doing so results in not only a technical improvement to a computing device, but does so in a way that stores data from the disparate sources in an optimized manner. The data is optimized as to storage capacity and storage access. Because of this, the computing device operates more efficiently than other devices that access electronic health records. This effectively frees up other computing resources for performing other processes.

The system described herein allows users to search for relevant medical providers and download, to their smartphones or other user devices, their respective electronic health records from the medical providers. In some examples, this connection may represent a data pipeline connection with the medical provider. A provider subscription system operates as an intermediary between user devices and gateways of the EHR systems. The gateways are effectively outlets or endpoints provided by the EHR systems. These endpoints are accessible for downloading data from the EHR systems.

Generally, the provider subscription system provides a process for onboarding new medical providers to the system. This includes storing provider information in a database that is searchable by the user devices. The provider information can include, for example, location information about the medical providers and configuration information for one or more gateways associated with the medical providers. The users can use their user devices to search the database to find their medical providers. To maintain user privacy, this searching is performed in a way that obfuscates, to the provider subscription systems, relationships between medical providers and searching users. Once medical providers have been identified by searching, the user devices receive provider information associated with the identified medical providers. The user devices use this provider information to establish connections with gateways associated with the identified medical providers. The gateways share electronic health records with the user devices using an industry standard format such as Fast Healthcare Interoperability Resource (FHIR) created by the Health Level Seven (HL7) International standards organization. Techniques described herein also manage the frequency at which the user devices connect to the gateways initially and in the future to check for updates to the electronic health records registered at the EHR systems.

Once the electronic health records have been downloaded to the user devices, they are stored using a first data model. The electronic health records are also processed using an indexing algorithm to index each medical term (e.g., a text string including one or more words) as a medical term expression (e.g., an index including one or more expression primitives). The medical term expressions which may be serialized, computational forms of the medical term are stored on the user device using a second data model. Information associating the medical terms and the medical term expressions is also saved on the user device. The medical term expression is useable to present, organize, search, and/or augment health record information from the electronic health records. This may be desirable to normalize medical entries in the electronic health records that have been entered by many different medical professionals. These medical professionals may use different formats, abbreviations, orders, words, synonyms, and other changes to describe the same thing. For example, a first doctor may write a prescription as "Tylenol 500 mg daily oral" and a second doctor may write the same prescription as "500 MG acetaminophen oral taken daily." Medically, these two prescriptions may be identical. However, conventional indexing systems may be unable to recognize this similarity. Using the medical term expressions described herein, these two prescriptions, which may be present in a user's electronic health record, can be represented in a uniform way (e.g., "Tylenol 500 MG oral daily"). In this manner, similar record entries in the electronic health record can be grouped together, identified during a search, and otherwise used for comparison.

With respect to using medical term expressions for grouping, all instances of "Tylenol" or "Tylenol 500 MG" across many different instances of the electronic health record may be grouped together and presented in a user interface. Using conventional techniques, it may only be possible to see those instances found in the relevant instance of the electronic health record. In this example, the user may be provided a richer and more complete picture of her medical history. This may prove useful for the user and/or medical professionals when making decisions about future care for the user.

With respect to using medical term expressions for searching, the user may search her medical history (e.g., a collection instances of her electronic health records) for information about her heart. To perform this search, the keyword heart may be converted to a medical term expression and used to search a database that includes the other medical term expressions from the electronic health record. Identified results may be presented in any suitable manner. The results may include instances in the electronic health record where the user's heart was mentioned (e.g., a timeline of medical events relating to the user's heart).

Contextual information in the form of metadata can be also associated with the medical term expressions. This contextual information can be used to enhance the underlying medical terms. For example, continuing with the prescriptions discussed above, ingredients, images of pills, usage instructions, and the like (e.g., types of metadata) can be associated with the medical term expressions and presented when "Tylenol 500 MG oral daily" is presented to the user.

Turning now to the figures, FIG. **1** illustrates a block diagram **102** and a flowchart showing a process **100** for enabling storage and retrieval of electronic health records on

user devices, according to at least one example. The diagram **102** includes user device **104**, which can be any suitable electronic user device capable of communicating with other electronic devices over a network such as the Internet. In some examples, the user device **104** can be a smartphone or other user device on which specialized applications can operate. The user device **104** is associated with or otherwise operated by a user **106**. The user **106** is an example of a patient whose electronic health records are the subject of this specification.

The diagram **102** also includes provider user device **108**. The provider user device **108** can be any suitable electronic user device capable of communicating with other electronic devices over a network such as the Internet. In some examples, the provider user device **108** can be a laptop, personal computer, or other user device on which a provider user **110** may interact. The provider user **110** is an example of a representative of a medical provider who uses the provider user device **108** to interact with a provider subscription system **112**. Medical information associated with the medical provider (e.g., electronic health records of patients of the medical provider) is stored at an EHR system **114**. The EHR system **114** may be associated with one or more medical providers (e.g., organization entities, brand entities, and/or location entities). In particular, the EHR system **114** may store, organize, and/or otherwise manage health record data generated by medical professionals of the medical providers. The EHR system **114** may include one or more gateways, each including one or more endpoints to enable multiple connections between the EHR system **114** and other electronic devices. In some examples, user devices such as the user device **104** may interact with the EHR system **114** using any suitable interfaces such as gateway application programming interfaces (API). The gateway APIs may define a set of function calls for communications between the EHR system **114** and the user device **104**.

FIGS. **1**, **3**, **18**, **19**, **20**, **35**, **36**, **38**, **39**, **40**, **41**, **43**, **44**, **45**, **46**, **47**, **48**, **50**, and **51** illustrate example flow diagrams showing processes **100**, **300**, **1800**, **1900**, **2000**, **3500**, **3600**, **3800**, **3900**, **4000**, **4100**, **4300** (shown on FIGS. **43** and **44**), **4500**, **4600**, **4700**, **4800**, **5000**, and **5100**, according to at least a few examples. These processes, and any other processes described herein, are illustrated as logical flow diagrams, each operation of which represents a sequence of operations that can be implemented in hardware, computer instructions, or a combination thereof. In the context of computer instructions, the operations may represent computer-executable instructions stored on one or more non-transitory computer-readable storage media that, when executed by one or more processors, perform the recited operations. Generally, computer-executable instructions include routines, programs, objects, components, data structures and the like that perform particular functions or implement particular data types. The order in which the operations are described is not intended to be construed as a limitation, and any number of the described operations can be combined in any order and/or in parallel to implement the processes.

Additionally, some, any, or all of the processes described herein may be performed under the control of one or more computer systems configured with specific executable instructions and may be implemented as code (e.g., executable instructions, one or more computer programs, or one or more applications) executing collectively on one or more processors, by hardware, or combinations thereof. As noted above, the code may be stored on a non-transitory computer-readable storage medium, for example, in the form of a computer program including a plurality of instructions executable by one or more processors.

The process **100** may begin at **116** by building a provider database **118**. This may be performed by the provider subscription system **112** based on information received from the provider user devices **108**. For example, the provider users **110** may use the provider user devices **108** to share information about the about provider entities with the provider subscription system **112**. As described herein, this information may be received and processed in a manner to create and maintain complex relationships between organization entities, brand entities, location entities, and gateway entities. Maintaining these relationships may prove useful for enabling efficient searching of medical providers and for identifying an appropriate gateway corresponding to an identified medical provider.

At **120**, the process **100** may include enabling a user device (e.g., the user device **104**) to search the provider database **118**. This may be performed by the provider subscription system **112** based on search queries received from the user devices **104**. For example, the users **106** may formulate search queries for medical providers using the user devices **104**. These queries may be transmitted to the provider subscription system **112**. As described herein, subsequent searching steps may be performed in a manner that obfuscates, from the provider subscription system **112**, the medical providers the user **106** is interested in. Depending on the obfuscation technique used, the user device **104** may manage the obfuscation and/or the provider subscription system **112** may manage the obfuscation. Once the appropriate medical provider has been identified, information about the EHR system **114**, which is associated with the medical provider, is provided to the user device **104**.

At **122**, the process **100** may include enabling the user device **104** to connect to a gateway (e.g., a gateway of the EHR system **114**) and download health record data. The user device **104** may connect to the EHR system **114** using the information about the EHR system **114** received from the provider subscription system **112**. Downloading health record data may include downloading electronic health records using the FHIR standard. In some examples, the user device **104** may connect to and download from more than one EHR system **114**.

At **124**, the process **100** may include processing medical terms from the health record data to index the medical terms. This may be performed by the user device **104**. In some examples, as described herein, indexing the medical terms may include generating medical term expressions corresponding to the medical terms. The medical term expressions may be a serialized form of the medical terms, which may be suitable for storing in a term base located on the user device **104**.

At **126**, the process **100** may include presenting the health record data based on the indexed medical terms. This may be performed by the user device **104**. As described herein, presenting the health record data may include using the indexed medical terms to present the health record data in a uniform manner. This may also include using the indexed medical terms to present contextual information together with the health record data.

At **128**, the process **100** may include providing feedback about the indexed medical terms. This may be performed by the user device **104**. As described herein, providing feedback about the indexed medical terms may be sent to a terminology management system **130**. The terminology management system **130** may be associated with the provider subscription system **112**. In some examples, the two systems **112**, **130**

may be implemented by the same set of computing devices. As described herein, the terminology management system **130** may include automated and manual workflows for updating a term base **132**, a version of which was relied upon by the user device **104** when performing the processing at **124**.

FIG. **2** illustrates a block diagram showing an example architecture or system **200** for enabling storage and retrieval of electronic health records on user devices, according to at least one example. The system **200** includes a few elements introduced in FIG. **1**. In particular, the system **200** includes the provider subscription system **112**, one or more user devices **104***a*-**104***n*, one or more EHR systems **114***a*-**114***n* associated with one or more medical providers **202***a*-**202***n*, the terminology management system **130**, an updater service **204**, and a business subscription system **206**. As appropriate and as illustrated by the arrows, the elements of the system **200** may be communicatively coupled via one or more networks.

Beginning with the business subscription system **206**, the business subscription system **206** may be any suitable collection of hardware and software components configured to collect, store, update, and otherwise manage business locations including those of the medical providers **202**. For example, the business subscription system **206** may include a business database **208** and a subscription service **210** to enable subscription of the medical provider **202**. When medical provider **202** is subscribed and active, the user devices **104** may be allowed to connect to and download health record data from the associated EHR system **114** (e.g., a gateway of the EHR system **114**).

As part of subscribing and managing subscriptions, the subscription service **210** may include functionality to collect, store, update, and otherwise manage business locations. In some examples, the subscription service **210** provides one or more user interfaces by which authorized users may input information about their location. This information may include geographic information (e.g., a physical address and pin on a map), image information (e.g., logos), contact information (e.g., business, legal, technical, etc.), and any other information relating to a business. The subscription service **210** may also be configured to create and/or update record entries in the business database **208** based on information received. For example, an authorized user associated with the medical provider **202** may share business information with the business subscription system **206**. Once this information has been shared and validated, the business information may published for public consumption (e.g., indexed for searching, made available on a map platform, shared directly with users, etc.).

The business database **208** may maintain the collected business information and any relationships between entities represented by the business information. In some examples, the business database **208** includes some or all of the information stored in the provider database **118**. For example, because the business subscription system **206** may be used to register all business (not just medical providers **202**), records for the medical providers **202** may be maintained in both the business database **208** and the provider database **118**. In some examples, the business subscription system **206** shares business information with the provider subscription system **112** in any suitable manner.

Turning now to the provider subscription system **112**, the provider subscription system **112** may include the provider database **118** introduced herein, a provider service **209**, and a test harness **211**. Generally, the provider subscription system **112** may validate the EHR systems **114**, maintain information about the medical providers **202** and associated EHR systems **114**, enable searching of the medical providers **202** associated with the EHR systems **114**, and manage access of the user devices **104** to the EHR systems **114**.

After a medical provider **202** associated with an EHR system **114** has been subscribed, the test harness **211** of the provider subscription system **112** may be used to test and/or otherwise validate that a test user using a test user device **104** can connect to and download data from the EHR system **114**. In this manner, the test harness **211** may simulate actions that one of the user devices **104** may perform to connect to the EHR system **114**. In some examples, the test harness **211** may test this connection when a medical provider **202** is first subscribed and at other times after the initial subscription. For example, the connection may be tested periodically, when certain conditions are fulfilled, and under any other circumstance. If the test is positive, a status indicator(s) in the provider database **118** associated with the medical provider **202**, the EHR system **114**, and/or a gateway associated with the EHR system **114** may be updated to reflect that the EHR system **114** or the gateway is/are active. If the test is negative, the status indicator(s) may be updated to reflect that the EHR system **114** is inactive. When active, the user devices **104** may be capable of connecting to the gateways of the EHR systems **114**. When inactive, the user devices **104** may be unable to connect to the gateways of the EHR systems **114**.

The provider service **209** may maintain information about the medical providers **202** and associated EHR systems **114** in the provider database **118**, enable searching of the medical providers **202** associated with the EHR systems **114**, and manage access of the user devices **104** to the EHR systems **114**. In some examples, the user devices **104** send requests to search for the medical providers **202** to the provider service **209**. The provider service **209** processes these requests and returns results. In some examples, as part of establishing a connection with one of the EHR systems **114**, the user device **104** will check in with the provider service **209** to determine whether any configuration information associated with the EHR system **114** has changed. The configuration information, which may be stored in the provider database **118** may include API information, provider identifiers, status indicator information, and any other suitable information relating to the configuration of the EHR system **114** and/or other entities associated with the EHR system **114**.

The user devices **104** may include a health application **212** and a term base **214**. Generally, the user devices **104** may be associated with and operated by different users (e.g., patients of the medical providers **202**). Functionally, the health application **212** may enable the user devices **104** to communicate with the provider subscription system **112** (e.g., to search for the medical providers **202**, obtain configuration information about the medical providers **202**, and perform other techniques), communicate with the EHR systems **114** of the medical providers **202** (e.g., to download data packages including electronic health records and/or updates to electronic health records and to perform other such techniques), communicate with the terminology management system **130** (e.g., to upload certain medical terms for refinement), and communicate with the updater service **204** (e.g., to receive updates to the term base **214**, indexing rules, and other such information relating to indexing medical terms).

In some examples, the term base **214** may include one or more relational databases or other suitable storage schema for storing expression primitives and/or medical term

expressions. For example, the term base **214** may be seeded with expression primitives from the term base **132**. As new medical term expressions are generated from medical terms (e.g., as medical terms from the electronic health records are indexed), these new medical term expressions may be stored in the term base **214**. Over time, the term base **214** may begin to represent relationships between expression primitives and medical term expressions that are specific to an electronic health record of a user of the user device **104**. In this manner, the term base **214** may maintain a personalized relational graph representing the electronic health record of the user.

The term base **214** may include a replicated portion of the term base **132**. As described herein, the updater service **204** may send updates to the user device **104** including, for example, updates to the term base **214** based on content of the term base **132**. The updater service **204** may be configured to send rule sets to the user device **104**. For example, these rules may be in the form of Property Lists (plists), other XML files, and in any other suitable form. These rules may be used as part of indexing medical terms.

Given storage considerations, it may be impractical for the term base **214** to include all of the information found in the term base **132**. Thus, in some examples, the terminology management system **130**, which may be Cloud-based system, may host one or more APIs that can be used to access the term base **132** to page in additional information (e.g., metadata) from the term base **132**. In this manner, the user device **104** can selectively download information from the term base **132** to the term base **214** in order to enhance the health record data already stored on the user device **104**. In some examples, in addition to metadata, new medical term expressions representing medical concepts, medical categories, medical items, may be downloaded from the term base **132** using the APIs.

To maintain patient privacy, API calls to the terminology management system **130** may include randomized term base identifiers and an obfuscated term index to retrieve the information from the terminology management system **130**.

The terminology management system **130** may be configured to manage aspects of the medical terminology described herein. In particular, the terminology management system **130** may receive medical terms from the user devices **104** and resolve their indexing, which may include manual and/or automated processes. For example, if the user device **104** (e.g., the health application **212** and the term base **214**) is unable to index a medical term or unable to index the term based on a comparison of indexing scores with one or more thresholds, the user device **104** may upload the medical term and any other associated information to the terminology management system **130**. In some examples, a term resolution workflow **216** is implemented to resolve the problematic medical terms. For example, the term resolution workflow **216** may include a set of manual processes for trained users to review the input medical term, the proposed medical term expression, etc. in order to improve the health application **212** and/or other components that index medical terms. When the term resolution workflow **216** resolves a medical term, updates may be made to the term base **132**, which may then be pushed or otherwise downloaded by the user device **104**. A terminology management service **218** may be configured to manage updates to the term base **132** and interact with other services described herein.

FIG. **3** illustrates a block diagram **302** and a flow chart showing the process **300** for onboarding medical provider entities on to a system that enables sharing of electronic health records between user devices and the gateways of the EHR systems **114**, according to at least one example.

The process **300** may begin at **304** receiving information **308** about a plurality of entities. In some examples, the information **308** may be received by the provider subscription system **112** and from the provider user device **108** and/or the business subscription system **206**. For example, the provider user **110** may use the provider user device **108** to provide the information **308** directly to the provider subscription system **112**. As an additional example, the provider user **110** may use the provider user device **108** to provide the information **308** to the business subscription system **206**. In any event, the information **308** may be transferred to the provider subscription system **112**. The information **308** about the plurality of entities may include information defining an organization entity **310**, one or more brand entities **312**, one or more location entities **314**, and/or one or more gateway entities **316**. FIGS. **5-17** illustrate in more detail a process by which the provider subscription system **112** may receive the information **308**.

At **318**, the process **300** may include creating relationships between the plurality of entities identified by the information **308**. In some examples, this may be performed by the provider subscription system **112**. Creating the relationships may be based on the information **308** and/or rule sets that define relationships. FIG. **4** illustrates example relationships between entities.

At **320**, the process **300** may include storing entity identifiers and the relationships between the entities in a database. In some examples, this may be performed by the provider subscription system **112**, which may store information in the provider database **118**. In some examples, the entities may be organized by organization as a primary class, with sub-classes relating to other entities related to the organization (e.g., brands, locations, and/or gateways). In some examples, the storing performed at **320** may include creating a record entry in the provider database **118** for a data object that includes the entity identifiers and associated relationships.

At **322**, the process **300** may include generating a search index for searching entities in the database (e.g., the provider database **118**). In some examples, this may be performed by the provider subscription system **112**. The search index may be any suitable index useable for searching the database.

At **324**, the process **300** may include enabling a user device (e.g., the user device **104** operated by the user **106**) to use the search index to search the database (e.g., the provider database **118**). In some examples, this may be performed by the provider subscription system **112**. Enabling the user device **104** may include providing a user interface by which the user **106** can enter search queries for searching for entities. The user **106** may desire to search for the entities in order to find the entities (e.g., brands and/or locations) where the user **106** obtains medical care. The information in the provider database **118** associates these entities with their respective gateway entities where the electronic health record is actually stored. In this way, the user **106** is able to search for provider entities and connect her user device **104** to the gateways associated with the provider entities. This may be desirable because searching for the provider entities (e.g., the locations where the user **106** receives care) may be more natural than searching for a gateway and/or EHR system **114** that hosts the data for those locations where the user **106** receives care.

FIG. **4** illustrates a block diagram showing a data structure **400** for storing relationships between entities of an organization entity **402**, according to at least one example. The

data structure **400** may include a data object that represents and associates brand entities **404***a* and **404***b*-**404***n*, location entities **406***a*, **406***b*, and **406***c*-**406***n*, and gateway entities **408***a*-**408***c* and **408***d*-**408***n*, all of which are associated with the same organization entity **402**. As illustrated, the organization entity **402** may be associated with any suitable number of brand entities **404**, location entities **406**, and/or gateway entities **408**. Relationships between the entities **404**, **406**, and **408** are shown using the connecting lines.

The organization entity **402** is an example of an organization (e.g., non-profit, university, corporation, or other business entity) that owns and operates medical care facilities. For example, the organization entity **402** may be a healthcare company such as Mayo Clinic. The organization entity **402** may be the highest level of granularity by which any other entity may be described. In some examples, the organization entity **402** itself is the umbrella under which divisions and/or affiliates operate. The data structure **400** is organized in a way that allows a user to easily search for and find the "place" where she obtains care. Because the organization entity **402** may not actually be the place where care is administered, the brand entities **404** and/or the location entities **406** are used to better represent these places.

The brand entities **404** are examples of the divisions and/or affiliates described above. For example, the organization entity Mayo Clinic may include a plurality of divisions such as Mayo School of Health Sciences, Mayo Medical Laboratory, and Mayo Clinic Health System. These divisions may be represented by the brand entities **404**. When a user searches for any of these "places" she will find the data structure **400**. The brand entities **404***a* and **404***b*-**404***n* are all examples of brands that fall within the organization entity **402**.

The location entities **406** are examples of physical locations where the brand entities **404** are located. In some examples, the location entities **406** may be known by different names and/or include multiple physical locations. Thus, the distinction in the data structure **400** between brand entities **404** and the location entities **406**. For example, the brand entity **404***a* may be associated with two location entities **406***a*, **406***b*. The two location entities **406***a*, **406***b* may be examples of buildings located on a medical campus branded under the brand entity **404***a*. The location entity **406***c* is associated with a single brand entity, **404***b*.

The gateway entities **408** are examples of EHR systems that are used to store health records of patients that visit the brand entities **404** and/or the location entities **406**. In addition, the EHR systems may provide patient portals, scheduling, contact management, billing, accounting, imaging management, and other services pertaining to the health care field. Examples of EHR systems include sold by: Epic®, Meditech®, CPSI™, Cerner®, McKesson®, Healthland®, Siemens®, Allscripts®, and others.

Gateway entities **408** may be associated with more than one location entity **406**, with more than one brand entity **404**, with a single brand entity **404**, and/or a single location entity **406**. For example, the gateway entities **408***a*, **408***b* are both associated with the location entity **406***a*. Gateway entities **408** may also be shared across more than one brand entity **404** and/or more than one location entity **406**. For example, the gateway entities **408***b*, **408***c* are shared between the location entities **406***a*, **406***b*. The gateway entities **408***a*-**40***bc* are all associated with the brand entity **404***a* (e.g., via the location entities **406***a*-**406***c*). Gateway entities **408** may also be associated directly with brand entities **404** (e.g., the gateway entity **408***d* and the brand entity **404***n*). Gateway entities **408** may also be dedicated to location entities **406** and/or brand entities **404**. For example, the gateway entity **408***n* is dedicated to the location entity **406***n*. In some examples, a single gateway entity **408** is associated with many location entities **406**, which may be associated with a single brand entity **404** and a single organization entity **402**. For example, Walgreens Pharmacy may utilize a single gateway entity **408** to service hundreds or even thousands of different location entities **406**, all of which may be located at distinct locations, but share in the same Walgreens name (e.g., have the same brand entity **404**).

The data structure **400** may maintain these complex relationships between the organization entities **402**, the brand entities **404**, the location entities **406**, and the gateway entities **408**. Maintaining these relationships may prove useful for enabling efficient searching of medical providers and for identifying an appropriate gateway corresponding to an identified medical provider.

FIGS. **5-16** illustrate example views **502***a*-**502***m* of a user interface **500** for onboarding provider entities on to a system that enables sharing of electronic health records between user devices and gateways of electronic health record system, according to at least one example. In particular, FIGS. **5-16** illustrates views **502***a*-**502***m* of the user interface **500**. The views **502***a*-**502***m* may be presented as a webpage on a user device or in any other suitable manner. In some examples, the provider subscription system **112** and/or the business subscription system **206** may provide the provider user device **108** operated by the provider user **110**.

The view **502***a*, illustrated in FIG. **5**, may include a progress area **504***a* for tracking progress of a series of actions (e.g., introduction, about yourself, business type, etc.). Each action may be completed as the system receives and processes information. The information may be received by users inputting text in one or more fields within a current action area **506***a* or by uploading the data in some other manner. In the view **502***a*, the current action area **506***a* includes fields for a user to input contact information and/or other information about the person who is providing the information. In some examples, this may be a user authorized by an organization entity to establish the relationship with the subscription system(s) **112**, **206**.

The view **502***b*, illustrated in FIG. **6**, may include a progress area **504***b* for tracking progress of a series of actions (e.g., introduction, about yourself, business type, etc.). Each action may be completed as the system receives and processes information. The information may be received by users inputting text in one or more fields within a current action area **506***b* or by uploading the data in some other manner. In FIG. **6**, the current action under consideration is the "Business Type" action. As part of this action, the user may select a business type from the current action area **506***b* that represents the organization. This is because the user interface **500** and associated system may be used to subscribe many different types of entities. Depending on the entity selected in the current action area **506***b*, the later data collection steps may be adjusted. For example, in the view **502***b*, the user has selected healthcare provider **508**. Because of this, later data collection steps may be tailored to entities that are healthcare providers **508**. In particular, data about gateways of electronic health record systems may be collected.

The remaining actions displayed in the progress area **504***b* are used to gather business information about the business, information about a head office or headquarters, address and other geographic location information, web links, email addresses, technical contacts, legal contacts, and other similar contacts.

The view **502***c*, illustrated in FIG. **7**, may include a recommendation **702** based on an earlier identification of the healthcare provider **508** as the entity type. The recommendation **702** includes a message that recommends to the user that they enable EHR gateway access. Enabling EHR gateway access may allow patients of the healthcare provider **508** to download health records to their user devices (e.g., mobile, smart phones). To go through the steps of providing information for enabling an EHR gateway, the user may select toggle **704**.

The view **502***d*, illustrated in FIG. **8**, may include a progress area **504***d* for tracking progress of a series of actions (e.g., health provider application, health provider information). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***d* or by uploading the information in some other manner. In FIG. **8**, as illustrated in the progress area **504***d*, the user is currently inputting information relating to the "Health Provider Applicant" action. Thus, the current action area **506***d* includes fields to input contact information for "Health Inc." In this example, information for a legal contact has been requested.

The view **502***e*, illustrated in FIG. **9**, may include a progress area **504***e* for tracking progress of a series of actions (e.g., health provider application, health provider information). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***e* or by uploading the information in some other manner. In FIG. **9**, as illustrated in the progress area **504***e*, the user is currently inputting information relating to the "Health Provider Information" action. Thus, the current action area **506***e* includes fields to input information about EHR gateways operated by the health provider. These fields relate to whether the EHR gateways are FHIR compliant and, if so, the EHR vendor. The EHR gateways are FHIR compliant when they are capable of outputting information using the FHIR standard. The type of information requested at a later time in this workflow may depend on the selected EHR vendor. EHR vendors that are not supported may be grayed out, not included in the list, or may be provided. When provided, a message may be displayed that indicates why the EHR vendor is not supported. Once an EHR vendor has been selected, the view **502***f* is presented.

The view **502***f*, illustrated in FIG. **10**, may include a progress area **504***f* for tracking progress of a series of actions (e.g., EHR gateway configuration, EHR contacts, FHIR endpoint configuration, FHIR test patient account, patient portal configuration, patient portal display, and EHR system locations). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***f* or by uploading the information in some other manner. In FIG. **10**, as illustrated in the progress area **504***f*, the user is currently inputting information relating to the "EHR gateway configuration" action. Thus, the current action area **506***f* includes fields to input information particularly about the EHR gateway selected in the view **502***e*. The action illustrated in the current action area **506***f* may include assigning the gateway a name (e.g., "Health prod"), identifying the EHR vendor and version (which may be prepopulated), identifying whether patient FHIR endpoints have been deployed, identifying a range of active patient records stored by the EHR gateway, and identifying an EHR vendor organization identifier. Once information has been received using the view **502***f*, the view **502***g* is presented.

The view **502***g*, illustrated in FIG. **11**, may include a progress area **504***g* for tracking progress of a series of actions (e.g., EHR gateway configuration, EHR contacts, FHIR endpoint configuration, FHIR test patient account, patient portal configuration, patient portal display, and EHR system locations). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***g* or by uploading the information in some other manner. In FIG. **11**, as illustrated in the progress area **504***g*, the user is currently inputting information relating to the "EHR contacts" action. Thus, the current action area **506***g* includes fields to input contact information for the EHR gateway. This may include an administrative contact, technical contact, and other such contacts. Once information has been received using the view **502***g*, the view **502***h* is presented.

The view **502***h*, illustrated in FIG. **12**, may include a progress area **504***h* for tracking progress of a series of actions (e.g., EHR gateway configuration, EHR contacts, FHIR endpoint configuration, FHIR test patient account, patient portal configuration, patient portal display, and EHR system locations). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***h* or by uploading the information in some other manner. In FIG. **12**, as illustrated in the progress area **504***h*, the user is currently inputting information relating to the "FHIR endpoint configuration" action. Thus, the current action area **506***h* includes fields to input information particular to the FHIR endpoint. Using these fields the user inputs URLs that are specific to the EHR gateway. In some examples, the URLs may be prepopulated based on other information input earlier. In any event, the URLs will be used by other systems for testing user connections and for connecting to the EHR gateway to download health data. Once information has been received using the view **502***h*, the view **502***i* is presented.

The view **502***i*, illustrated in FIG. **13**, may include a progress area **504***i* for tracking progress of a series of actions (e.g., EHR gateway configuration, EHR contacts, FHIR endpoint configuration, FHIR test patient account, patient portal configuration, patient portal display, and EHR system locations). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***i* or by uploading the information in some other manner. In FIG. **13**, as illustrated in the progress area **504***i*, the user is currently inputting information relating to the "FHIR test patient account" action. Thus, the current action area **506***i* includes fields for a username and password. The username and password may belong to a test profile that the EHR gateway maintains. The username and password may be used periodically to test connections with the EHR gateway (e.g., by the test harness **211**). Once information has been received using the view **502***i*, the view **502***j* is presented.

The view **502***j*, illustrated in FIG. **14**, may include a progress area **504***j* for tracking progress of a series of actions (e.g., EHR gateway configuration, EHR contacts, FHIR endpoint configuration, FHIR test patient account, patient portal configuration, patient portal display, and EHR system locations). Each action may be completed as the system receives and processes information input by the user. The

information may be received by the user inputting text in one or more fields within a current action area **506***j* or by uploading the information in some other manner. In FIG. **14**, as illustrated in the progress area **504***j*, the user is currently inputting information relating to the "patient portal configuration" action. Thus, the current action area **506***j* includes fields for receiving information for configuring a patient portal. The patient portal may enable a user to connect to the EHR using a web browser to view and/or interact with the EHR gateway. For example, MyChart® provided by EPIC® systems is an example of a patient portal. The systems described herein may use established patient portals to authenticate users who wish to connect to EHR gateways. Thus, the fields in the current action area **506***j* relate to the patient portal. These fields are used to gather configuration information for the patient portal, which includes size range, registered user range, login URL, home URL, signup URL, and forgot username/password URL. These URLs may be used within the health application **212** when the user device is used to connect to the EHR gateway. For example, even if the user has not previously signed up with the patient portal, a patient portal signup screen can still be presented to the user. Once information has been received using the view **502***j*, the view **502***k* is presented.

The view **502***k*, illustrated in FIG. **15**, may include a progress area **504***k* for tracking progress of a series of actions (e.g., EHR gateway configuration, EHR contacts, FHIR endpoint configuration, FHIR test patient account, patient portal configuration, patient portal display, and EHR system locations). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***k* or by uploading the information in some other manner. In FIG. **15**, as illustrated in the progress area **504***k*, the user is currently inputting information relating to the "patient portal display" action. Thus, the current action area **506***k* includes fields for receiving particular branding information for the EHR gateway. This may include information relating to a brand/tradename, a patient portal title, a patient portal description, images, and an example representation **1502** of how the EHR gateway will look in the health application **212**. Once information has been received using the view **502***k*, the view **502***l* is presented.

The view **502***l*, illustrated in FIG. **16**, may include a progress area **504***l* for tracking progress of a series of actions (e.g., EHR gateway configuration, EHR contacts, FHIR endpoint configuration, FHIR test patient account, patient portal configuration, patient portal display, and EHR system locations). Each action may be completed as the system receives and processes information input by the user. The information may be received by the user inputting text in one or more fields within a current action area **506***l* or by uploading the information in some other manner. In FIG. **16**, as illustrated in the progress area **504***l*, the user is currently inputting information relating to the "EHR system locations" action. Thus, the current action area **506***l* includes a toggle button for adding another location. For example, if the provider "Health Inc." includes more than one EHR system, the user may add the information about this EHR system using the toggle button. In some examples, this may cause a repeat of the progress actions illustrated in the progress area **504***l*. Once information has been received using the view **502***l*, the view **502***m* is presented.

The view **502***m*, illustrated in FIG. **17**, may include a progress area **504***m* for tracking progress of a series of actions (e.g., complete application, review complete, test FHIR configuration, etc.). Each action may be completed as the system receives and processes information input by the user. In FIG. **17**, as illustrated in the progress area **504***m*, the user is currently on the "test FHIR endpoint connection" action. The "complete application" action was previously performed with respect to FIGS. **7-16**. The "review complete" action may have been performed by the entity that operates the provider subscription system **112** and/or the business subscription system **206**. In some examples, the "review" action is a manual process and/or an automated process. In a current action area **506***m*, is illustrated information about a FHIR endpoint of the EHR gateway. The current action area **506***m* may also include a test button **1702** and a review button **1704**. Selecting the test button **1702**, the enable the system to go through a predefined test (e.g., a simulation) routine to test the FHIR endpoint. This test routine may include attempting to connect to the EHR gateway at the FHIR endpoint using the test patient username and the test patient password input in the view **502***i*. If the connection is successful, the system also attempt to download health record data from the FHIR endpoint as a FHIR data package. Once the test has been successfully run, the review button **1704** may be selected to submit the FHIR endpoint for final review prior to be published and made available for user searching. In some examples, the information input using the views **502***a*-**504***m* may be used to generate the data structure **400**.

FIG. **18** illustrates an example flow chart showing the process **1800** for managing user authentication as part of establishing connections to gateways of EHR systems **114** to download electronic health records from the medical provider entities, according to at least one example. The process **1800** may be performed by the provider subscription system **112**, the user device **104**, and/or the EHR system **114**, including a gateway entity.

The process **1800** may begin at **1802** maintaining a client secret. This may be performed by the provider subscription system **112**. The client secret may be specific to a particular EHR system and/or to particular brand of EHR systems.

At **1804**, the process **1800** may include periodically updating the client secret. This may be performed by the provider subscription system **112**. In some examples, updating the client secret may include generating a new client secret. Updating the client secret periodically may include updating the client secret at a set interval (e.g., every month), in response to fulfillment of certain conditions, and at any other time. In some examples, updating the client secret may be performed when there is concern that the client secret may have been compromised.

At **1806**, the process **1800** may include providing the client secret and a client identifier. This may be performed by the provider subscription system **112**. The client identifier may be specific to the user device **104** and/or a user account associated with a user of the user device **104**. In some examples, the client secret and the client identifier may be provided to the user device **104**.

At **1808**, the process **1800** may include providing the client secret and the client identifier. This may be performed by the user device **104**. In some examples, the user device provides the client secret and the client identifier to the EHR system **114**.

At **1810**, the process **1800** may include providing client credentials. This may be performed by the user device **104**. The client credentials may be specific to a user associated with the user device **104**. The client credentials may be associated with a patient portal of the EHR system **114**. The user device **104** may provide the client credentials to the

EHR system **114**. In this manner the user may log in to the user portal at the EHR system **114**.

At **1812**, the process **1800** may include providing a code. This may be performed by the EHR system **114**. The code may be generated by the EHR system **114** for purposes of connecting with the user device **104**. The EHR system may provide the code to the user device **104**.

At **1814**, the process **1800** may include providing the client secret, the client identifier, and the code. This may be performed by the user device **104**. These items may be provided to the EHR system **114** in response to receiving the code.

At **1816**, the process **1800** may include providing an access token and a refresh token. This may be performed by the EHR system **114**. These items may be provided to the user device **104**. These item(s) may be used by the user device **104** at a later time to access the EHR system **114**. When later communications from the user device **104** include these item(s), and in some examples other information, the EHR system **114** may process the communications (e.g., download data to the user device **104**).

At **1818**, the process **1800** may include provide the refresh token, the client identifier, and the client secret. This may be performed by the user device **104**. These items may be provided to the EHR system **114**. In some examples, providing this information may enable a connection to be established between the user device **104** and the EHR system **114**.

At **1820**, the process **1800** may include establishing a data connection with the user device. This may be performed by the EHR system **114**. In some examples, establishing the data connection may depend in part on receiving the refresh token, the client identifier, and the client secret.

At **1822**, the process **1800** may include downloading first health record data from the EHR system **114**. This may be performed by the user device **104**. Such downloading, like the other communications described herein, may take place over any suitable network or combination of networks. The first health record data may be associated with an electronic health record of a user of the user device **104**.

At **1824**, the process **1800** may include providing the access token and a new refresh token. This may be performed by the EHR system **114**. These items may be provided to the user device **104**.

At **1826**, the process **1800** may include downloading second health record data from the EHR system **114**. This may be achievable based on the access token and the new refresh token.

FIG. **19** illustrates an example flow chart showing the process **1900** for managing entity relationships, according to at least one example. The process **1900** may be performed by the provider subscription system **112** and/or the business subscription service **206**.

The process **1900** may begin at **1902** by receiving information about a plurality of location entities and at least one gateway entity. The information may be received from a first user device such as a provider user device operated by a provider user (e.g., an authorized user). The plurality of location entities and the at least one gateway entity may be associated with respective entity identifiers. The entity identifiers may be assigned to the entities in any suitable manner and may uniquely identify the entities.

In some examples, receiving the information may include receiving at least a first portion of the information from a configuration file uploaded to the server from the first user device. In this example, the configuration file may include configuration information useable by the second user device for connecting to the at least one gateway.

In some examples, the information comprises configuration information useable by the second user device for connecting to the at least one gateway. The configuration information may include a plurality of links resolving to the at least one gateway.

At **1904**, the process **1900** may include associating the plurality of location entities with the at least one gateway entity. This may be based at least in part on the information received at **1902**. In some examples, associating the plurality of location entities with the at least one gateway entity creates a set of location-gateway relationships. The at least one gateway may be shared between at least two of the plurality of location entities. In some examples, the gateway may be devoted to a single location entity.

At **1906**, the process **1900** may include storing the respective entity identifiers and the set of location-gateway relationships in a database. The database, which may be referred to as a provider database, may include a plurality of data objects representing a plurality of organizations each including locations, brands, and gateways.

At **1908**, the process **1900** may include enabling a second user device to search the database. The second user device may be a device of a patient or other user who is interested in downloading health record data. Such searching may be for at least one entity of the plurality of location entities or the at least one gateway entity.

In some examples, the process **1900** may further include, prior to receiving the information, providing a user interface at the user device, the user interface comprising a plurality of text fields. In this example, receiving the information at **1902** may include receiving at least a first portion of the information via text input into the plurality of text fields. An example user interface is illustrated in FIGS. **5-17**.

In some examples, the process **1900** may further include, prior to storing the respective entity identifiers and the set of location-gateway relationships in a database, simulating a user connection to the at least one gateway using test user credentials identified from the information.

In some examples, the information may include information about a plurality of brand entities. In this example, the process **1900** may further include associating, based at least in part on the information, the plurality of brand entities with the plurality of location entities to create a set of brand-location relationships. At least two location entities of the plurality of location entities may be shared between at least one location entity of the plurality of location entities. In this example, the process **1900** may further include storing the respective entity identifiers and the set of brand-location relationship in the database. The respective entity identifiers, the set of location-gateway relationships, and the set of brand-location relationships may be stored in a data object associated with an organization entity.

FIG. **20** illustrates a block diagram **2002** and a flowchart showing the process **2000** for anonymized user searching of medical provider entities, according to at least one example. The diagram **2002** includes the user device **104**, which may be operated by the user **106**, and the provider subscription system **112** including the provider database **118**.

The process **2000** may begin at **2004** by providing a search query including search terms. This may be performed by the user device **104**. In some examples, the user **106** may operate the user device **104** to input the search terms, which may then be provided to the provider subscription system **112**. The search terms may relate to a medical provider that the user **106** desires to find. Once found, the user **106** may

operate the user device **104** to connect to a gateway of an EHR system of the medical provider and download her electronic health record.

At **2006**, the process **2000** may include receiving search results including a minimum number of entities. This may be performed by the user device **104**. The provider subscription system **112** may process the search query to identify the minimum number of entities from the provider database **118**. The entities in the minimum number may be location entities, brand entities, and/or gateway entities, all of which may be considered medical provider entities. The minimum number may correspond to some fixed value such as, for example, five, ten, twenty, fifty, etc. If processing the search query alone does not result in the minimum number (e.g., if the search terms were too narrow), the provider subscription system **112** may automatically add additional entities to the set to reach the minimum number.

At **2008**, the process **2000** may include receiving user selection of an entity from the minimum number of entities. This may be performed by the user device **104**. For example, the user **106** may use the user device **104** to select the entity from a list including the minimum number of entities. This may be the entity that the user **106** is interested in connecting to (e.g., a location where the user **106** obtains medical care).

At **2010**, the process **2000** may include storing identifying entity identifiers for the entity and other entities in the minimum number of entities. This may be performed by the user device **104**. For example, upon selection of the entity from the list, e.g., at **2008**, the user device **104** may automatically store identifiers for the entities from the minimum number of entities. The identifiers may be universal unique identifiers, which may be generated by the provider subscription system **112** or assigned in some other manner.

At **2012**, the process **2000** may include providing a request for information about the first entity. The request may include the entity identifier and the other entity identifiers. This may be performed by the user device **104**. For example, the user device **104** may provide the request to the provider subscription system **112**. Thus, even though the user **106** is only interested in the first entity, the user device **104** may nevertheless send identifiers for the first entity together with the other entity identifiers. In this manner, the entity that the user **106** is actually interested in is obfuscated from the provider subscription system **112**. When later calls are made by the user device **104** to the provider subscription system **112** for information about the first entity, the same set of identifiers may be used.

At **2014**, the process **2000** may include receiving information about the entity and the other entities in the minimum number of entities. This may be performed by the user device **104**. For example, the provider subscription system **112** may gather up the information, e.g., from the provider database **118** or other location, and send the information to the user device **104**. Again, even though the user **106** is only interested in the first entity, the user device **104** receives information about all entities from the minimum number of entities. However, because the user device **104** is aware that the first entity is what the user **106** is actually interested in, the user device **104** may sort through the information received to identify the relevant information about the first entity and disregard the other information about the other entities.

At **2016**, the process **2000** may include using the information about the entity. This may be performed by the user device **104**. Using the information may include using the information to connect to a gateway entity associated with the entity to download health record data to the user device **104**.

FIGS. **21-33** illustrate a series of processes, decision points, and user interface (UI) views relating to a user operating a health application of a user device to connect to a gateway entity for downloading health record data, according to various examples. In particular, FIGS. **21-24** include processes (a), (b), (c), (d), decision points (A), (B), (C), (D), (E), (F), (G), and (H), and user interface (UI) views labeled (1) through (25) that result from the processes (a)-(d) and the decisions points (A)-(H). A selection made at a UI view that carries over between a first FIG. and a second FIG. is illustrated, for example, using a graphic of the following form: , in which the (2) uniquely identifies the selection. A process that carries over between a first FIG. and a second FIG. is illustrated, for example, using a graphic of the following form: , in which the "1" represents the UI view (1) and the "d" represents the process (d). A selection at a decision point that carries over between a first FIG. and a second FIG. is illustrated, for example, using a graphic following the form: , in which the "B" represents the decision point (B) and the "a" represents the option (a) at the decision point (B). A selection that is directed to a decision point and carries over between a first FIG. and a second FIG. is illustrated, for example, using a graphic following the form: , in which "A" represents the target decision point (e.g., decision point (A)).

FIG. **21** illustrates a user starting point (1), which identifies the processes (a)-(d), and UI view (2). The UI view (2) may be presented when the user first accesses the health application and has already added a health record (e.g., "(a) health records add account"). Currently, a single record has been added, which appears incomplete because all categories, except all records, include a zero value. As more health records are added, the number of record entries in the categories will begin to increase. The user may add more accounts by selecting the "add account" UI element. This selection results in decision point (A), illustrated in FIG. **23**.

FIG. **22** illustrates user starting point (1) for processes (c) ("sources tab add account") and (b) ("health records get started") respectively as UI views (3) ("health records welcome UI") and (4) ("sources add account UI"). The UI view (3) may be presented when the user accesses the health application and selects an option for getting started with health records, which corresponds to the process (b). Thus, the UI view (3) may include a welcome message that includes information about accessing the user's health records, including downloading the health records to the user's user device using the user's patient portal. The user may begin the process for adding health records by selecting the "get started" UI element. This selection results in decision point (A), illustrated in FIG. **23**.

The UI view (4) may be presented when the user accesses the health application and selections an option for adding an account, which corresponds to the process (c). Thus, the UI view (4) may include a UI element selectable to "add account" associated with a medical provider. The UI view (4) may also present a set of other applications relating to the health application. The user may begin the process for adding health records by selecting the "add account" UI element. This selection results in decision point (A), illustrated in FIG. **23**.

FIG. **23** illustrates the UI view (5) ("email deeplink"), the UI view (6) ("featured locations UI"), the decision point (A), and the decision point (B). At the decision point (A) it is determined whether location is enabled, e.g., has the user authorized the health application to access location data about the user device. If location is enabled, then in the UI view (6), the list of providers is served up based on location. If location is not enabled, then in the UI view (6), the list of providers is served up alphabetically (e.g., as illustrated in FIG. **23**). The list of providers may be provided to the user device by the provider subscription system **112** in response to the user entering search terms into the search box in the UI view (6). The UI view (6) may include a prompt that reminds the user to search for healthcare locations that they have visited in the past. The list of providers included in the UI view (6) may include a variety of different healthcare providers. Selection of one of the providers included in the UI view (6) may result in presentation of the UI view (9), as illustrated in FIG. **25**.

The UI view (5) may be presented when the user accesses the health application and selects an option for emailing a deep link to connect to the gateway, which corresponds to the process (d) from FIG. **21**. Thus, the UI view (5) is an example, email application including an example email from a medical provider, "New York-Presbyterian." In some examples, the deep link may be generated by the provider subscription system and shared with the medical provider. In some examples, the medical provider generates the deep link. In any event, the deep link may be shared by the medical provider (e.g., via email or in some other way) with its patients as part of inviting the patients to connect to the medical provider. The body of the email may explain to the user how to connect and which credentials to use (e.g., "user your myNYP credentials"). These credentials may correspond to the NYP's patient portal. The UI view (5) includes a UI element selectable to begin the process of connection with the health application. This selection results in decision point (B), as illustrated in FIG. **23**.

At the decision point (B) it is determined whether the email (e.g., illustrated in the UI view (5) is opened on a supported device. If the email is opened on a supported device (b) (e.g., a mobile user device that can be used to download the health record, as opposed to a desktop computer), then following (Bb), the UI view (7) is presented, as illustrated in FIG. **24**. If the email is opened on an unsupported device (a), then following (Ba), the UI view (8) is presented, as illustrated in FIG. **24**.

FIG. **24** illustrates the UI view (7) ("welcome UI from email") and the UI view (8) ("yourhealth.com"). The UI view (7) may be presented within the health application. The UI view (7) may include a welcome message that includes information about accessing the user's health records, including downloading the health records to the user's user device using the user's patient portal. The UI view (7) may also include a UI element selectable to get started accessing one's health records. This selection results in presentation of the UI view (14), as illustrated in FIG. **26**.

The UI view (8) may be presented within a web browser on the user device. The UI view (8) may recommend that the user download the health application on her user device. For example, if the user opened the email from the UI view (5) on her laptop computer, the UI view (8) may be presented that explains the health application and prompts the user to open her user device and download or otherwise access the health application.

FIG. **25** illustrates the UI view (9) ("search UI"), the UI view (10) ("provider detail UI—multiple locations"), and the decision point (C). The UI view (9) may be presented within the health application. The UI view (9) may include a list of medical providers based on the search query "NewYork-Presbyterian." The results are identified by (a), (b), (c), and (d). Each medical provider in the list may include details about the medical provider sufficient to enable the user to make an informed decision about each (e.g., decide which of the medical provider is the one at which she obtains care). Selection of the medical provider (a) ("NewYork-Presbyterian Lower Manhattan Hospital") results in the decision point (C).

At the decision point (C) it may be determined whether the selected medical provider has one or many gateways. For example, some medical providers may have a single gateway (e.g., Walgreens) that supports many locations. Other medical providers may have multiple gateway that support a single location. The data structure **400** may be accessed at the decision point (C). If the medical provider has one gateway (a), then the UI view (14) is presented, as illustrated in FIG. **26** by following (Ca). If the medical provider has more than one gateway (b), then the UI view (15) is presented, as illustrated in FIG. **27** by following (Cb).

Selection of the medical provider (c) ("CUMC/Columbia Doctors") in the UI view (9) results in presentation of the UI view (10). The UI view (10) may be presented because the selected medical provider (c) is associated with more than one location. Thus, in the UI view (10), the user may be prompted to select the particular location affiliated with CUMC/Columbia Doctors where the user obtains care.

Selection of the medical provider (d) ("CUMC/New-York Presbyterian Morgan Stanley Children's Hospital") in the UI view (9) results in presentation of the UI view (11), as illustrated in FIG. **26** by following (**9***d*). The UI view (11) may be presented when the selected location is unsupported by the health application.

FIG. **26** illustrates the UI view (11) ("provider detail UI—unsupported") and the UI view (14) ("provider detail UI—supported"). The UI view (11) may be presented within the health application after selection of an unsupported medical provider in the UI view (9), shown as (**9***d*). The UI view (11) includes contact information for the unsupported medical provider and a message prompting the user to contact the unsupported medical provider and request support.

The UI view (14) may be presented within the health application after selection of a supported medical provider in the UI view (9) and which has a single gateway, shown as (Ca) from the decision point (C). The UI view (14) includes information about the medical provider and about a gateway of the medical provider that can be connected to. A UI element that identifies the "myNYP" patient portal is selectable to continue the process of connecting to the gateway. Selection of the UI element identifying the "myNYP" patient portal results in the decision point (D), as illustrated in FIG. **27**.

FIG. **27** illustrates the UI view (15) ("provider detail UI multiple gateways") and the decision point (D). The UI view (15) may be presented within the health application after selection of a supported medical provider in the UI view (9), which has a more than one gateway, shown as (Cb) from the decision point (C). Thus, the UI view (15) includes information about the three possible gateways (e.g., "myColumbiDoctors," "Weill Cornell CONNECT," and "myNYP") associated with the medical provider that can be connected to. In some examples, the user may be required to connect to all three gateways in order to obtain all of her health records from the medical provider. A UI element that iden-

tifies the "myNYP" patient portal is selectable to continue the process of connecting to the gateway. Selection of the UI element identifying the "myNYP" patient portal results in presentation of the UI view (17), as illustrated in FIG. **29**.

At the decision point (D) it may be determined whether the selected gateway is available. For example, some gateways, while registered in the provider database, may be unavailable during certain periods of time. A record associated with the gateway in the provider database may indicate availability of the gateway. In some examples, periodic testing of the gateway may be used to update the record (e.g., from available to unavailable). If the gateway is unavailable (a), then the UI view (12) is presented, as illustrated in FIG. **28** by following (Da). If the gateway is available (b), then the UI view (13) is presented, as illustrated in FIG. **28** by following (Db).

FIG. **28** illustrates the UI view (12) ("gateway detail UI unavailable"), the UI view (13) ("gateway detail UI available"), and the UI view (16) ("sign in"). The UI view (12) may be presented within the health application after it is determined at the decision point (D) that the gateway is unavailable. Thus, the UI view (12) includes a message informing the user that a connection is unavailable because the gateway is unavailable. The UI view (12) may also include links and/or contact information for the gateway and/or medical provider associated with the gateway. In this manner, the user may contact the medical provider directly to resolve the issue.

The UI view (13) may be presented within the health application after it is determined at the decision point (D) that the gateway is available. Thus, the UI view (13) includes a UI element (e.g., connect button) selectable by the user to connect to the available gateway. If the user has made it this far in the process, but has forgotten her password or would like to sign up for the patient portal, the user may click on links provided in the UI view (13). In some examples, this information presented (e.g., messages and links) may be gathered as described with reference to FIGS. **5-17**. If the user selects the connect button, the UI view (16) may be presented within the health application. The UI view (16) may include fields for the user to input credentials including a username and password. These credentials may be specific to the gateway to which the user is connecting (e.g., myNYP associated with New-York Presbyterian—The University Hospital of Columbia and Cornell). A UI element that allows the user to sign in (e.g., the sign in button) is selectable to continue the process of connecting to the gateway. Selection of the sign in button results in presentation of the UI view (18), as illustrated in FIG. **29**.

FIG. **29** illustrates the UI view (17) ("gateway detail UI connected") and the UI view (18) ("allow access"). The UI view (17) may be presented within the health application after selection of the "myNYP" item in the UI view (15). The UI view (17) may include a message informing the user that a connection has already been made between this gateway and the user device. The UI view (18) may be presented within the health application after selecting the sign in button in the UI view (16). The UI view (18) may include a prompt about connecting the user device to the gateway. When more than one users are associated with the user device and/or the gateway, the UI view (18) may be used to select the appropriate user (e.g., John Lane or Jill Appleseed). A UI element that allows the user to grant access (e.g., the allow access button) is selectable to continue the process of connecting to the gateway. Selection of the allow access button results in presentation of the UI view (19), as illustrated in FIG. **30**.

FIG. **30** illustrates the UI view (19) ("transient connecting UI"), the UI view (20) ("successful connection"), and the decision point (E). The UI view (19) may be presented within the health application after granting access by selecting the allowing access button in the UI view (18). At the decision point (E) it may be determined whether the connection to the gateway was successful. If the connection was successful (a), then the UI view (20) is presented, as illustrated in FIG. **30**. If the connection was unsuccessful (b), then the UI view (21) is presented, as illustrated in FIG. **31** by following (Eb). The UI view (20) may be presented within the health application when it is determined at the decision point (E) that the connection was successful. The UI view (20) may include a message informing the user that she will get an alert once her records have been downloaded. From this point on, the downloading of records may be more or less automatic. In some examples, the user device may contact the gateway periodically to determine whether there are updates. In some examples, the gateway may send the updates periodically.

FIG. **31** illustrates the UI view (21) ("unable to connect) and the decision point (F). The UI view (21) may be presented within the health application when it is determined at decision point € that the user device was unable to connect to the gateway. Thus, the UI view (21) may include a message informing the user about the inability to connect to the gateway. At the decision point (F) it may be determined whether the user has opted in to sharing data with the subscription provider system. If the user has not yet opted in to sharing (a), then the UI view (22) is presented, as illustrated in FIG. **32** by following (Fa). If the user has opted in to sharing (b), then the decision point (H) is traversed, as illustrated in FIG. **32**, by following (Fb).

FIG. **32** illustrates the UI view (22) ("confirm download"), the UI view (23) ("health record inbox—connected"), and the decision point (H). The UI view (22) may be presented within the health application when it is determined at the decision point (F) that the user has not yet opted in to sharing. In some examples, opting in to sharing may mean that the user agrees to share certain data with the operator of the provider subscription system. The system may use this data to improve the functionality of the health application. If the user agrees to share data, no identifying data will be shared with the system. Instead, the data will be anonymized and/or otherwise disconnected from the user. The UI view (22) may also include link to learn more about privacy.

As described above, one aspect of the present technology is the gathering and use of data available from various sources to improve the functioning of devices that index medical terms. The present disclosure contemplates that in some instances, this gathered data may include personal information data that uniquely identifies or can be used to contact or locate a specific person. Such personal information data can include demographic data, location-based data, telephone numbers, email addresses, health record data, home addresses, or any other identifying information.

The present disclosure recognizes that the use of such personal information data, in the present technology, can be used to the benefit of users. The present disclosure further contemplates that the entities responsible for the collection, analysis, disclosure, transfer, storage, or other use of such personal information data will comply with well-established privacy policies and/or privacy practices. In particular, such entities should implement and consistently use privacy policies and practices that are generally recognized as meeting or exceeding industry or governmental requirements for

maintaining personal information data private and secure. For example, personal information from users should be collected for legitimate and reasonable uses of the entity and not shared or sold outside of those legitimate uses. Further, such collection should occur only after receiving the informed consent of the users. Additionally, such entities would take any needed steps for safeguarding and securing access to such personal information data and ensuring that others with access to the personal information data adhere to their privacy policies and procedures. Further, such entities can subject themselves to evaluation by third parties to certify their adherence to widely accepted privacy policies and practices.

Despite the foregoing, the present disclosure also contemplates examples in which users selectively block the use of, or access to, personal information data. That is, the present disclosure contemplates that hardware and/or software elements can be provided to prevent or block access to such personal information data. For example, in the case of medical data term sharing, the present technology can be configured to allow users to select to "opt in" or "opt out" of participation in the collection of personal information data during registration for services.

Therefore, although the present disclosure broadly covers use of personal information data to implement one or more various disclosed examples, the present disclosure also contemplates that the various examples can also be implemented without the need for accessing such personal information data. That is, the various examples of the present technology are not rendered inoperable due to the lack of all or a portion of such personal information data.

Regardless of the user's selection at the UI view (22), the decision point (H) may be considered. At the decision point (H) it may be determined, based on where the user first started the connection process, where to go next, e.g., (a), (b), or (c). If (a), the UI view (23) will be presented. If (b), the UI view (24) will be presented, as illustrated in FIG. **33**. If (c), the UI view (25) will be presented, as illustrated in FIG. **33**.

The UI view (23) may be presented within the health application when it is determined at the decision point (E) that the user started from HR summary—add account button. The UI view (23) may include a summary of all health records included on the user device and a list of those gateways that are connected (e.g., "New York Presbyterian" and "Columbia University Medical").

FIG. **33** illustrates the UI view (24) ("HR summary—downloading data") and the UI view (25) ("source add account UI—connected"). The UI view (24) may be presented within the health application when it is determined at the decision point (F) that the user started from HR summary—get started button. The UI view (25) may be presented within the health application when it is determined at the decision point (F) that the user started from the source tab—add account button. In the UI view (25), the user may select an update interval at which new records will be updated.

FIG. **34** illustrates a diagram **3400** depicting a geographic approach for constructing a batch **3402** of medical provider entities for enabling anonymized user searching of medical provider entities, according to at least one example. The batch **3402** is similar to the data structure **400** in that it includes relationships between brand entities **404**, location entities **406**, and gateway entities **408**. The batch **3402**, however, may not be associated with an organization entity. This is because, instead of being organized by organization entity, the batch **3402** is organized geographically based on a starting medical provider, which in this example is medical provider **3404***a*, and unique to the medical provider **3404***a*. The batch **3402** may be identified by a unique batch identifier.

The medical provider **3404***a* is a physical location where patients can obtain care (e.g., an address). The medical provider **3404***a* may also be associated with a brand by which patients identify the medical provider **3404***a* (e.g., a name of the practice, name of an operating entity, etc.).

The diagram **3400** also includes a graphical depiction of an outward expanding geographic search **3406**. The outward expanding geographic search **3406** may include a plurality of bands **3408***a*-**3408***d*. Each of the plurality of bands **3408** is centered at the medical provider **3404***a*, expands outwardly, and thereby increases in diameter from **3408***a*-**3408***d*. The area of the bands **3408** corresponds to actual land area (e.g., on a map). For example, the medical provider **3404***a* may be located at a city center and the bands **3408** may extend towards the suburbs (e.g., periphery of the city).

The outward expanding geographic search **3406** depiction corresponds to a process of building the batch **3402**. For example, the process may begin by selecting the medical provider **3404***a*. In this example, the batch **3402** may be uniquely created for the medical provider **3404***a*. Later when users request information about the medical provider **3404***a* (e.g., as part of searching the provider database **118**), the users will receive information about all or a portion of the entities in the batch **3402**, including the medical provider **3404***a*. In this manner, the true identity of the medical provider **3404***a* may be obfuscated from the server that is enabling the searching.

Beginning with the medical provider **3404***a*, a first outward expanding search may be performed as represented by the band **3408***a*. During this first outward expanding search, the medical provider **3404***a* and a medical provider **3404***b* are identified. Once any medical provider **3404** has been identified, brand information, location information, and gateway information for the identified medical provider **3404** is added to the batch **3402** (e.g., a data object that includes the information represented by the batch **3402**). Thus, as illustrated using similar object fill, the first outward expanding search represented by the band **3408***a* revealed brand entity **404***a*, location entities **406***a*, **406***b*, and gateway entity **408***a*. In this example, the two medical providers **3404***a*, **3404***b* correspond to the same brand entity (e.g., the brand entity **404***a*), each correspond to one of the location entities **406***a*, **406***b*, and correspond to the same gateway entity (e.g., the gateway entity **408***a*). Relationships between the brand entities **404**, the location entities **406**, and the gateway entities **408** are represented by connecting lines. These relationships may have been previously defined and/or may be defined using the techniques described herein.

The outward expanding search may be incrementally increased (e.g., increasing search radius by 1 mile) until threshold numbers of brand entities, location entities, and/or gateway entities have been achieved. The threshold numbers may be different values or the same values. Thus, in this example, three more searches are performed following the first search. These three other searches, discussed below, correspond to the bands **3408***b*, **3408***c*, and **3408***d*. Additional or fewer searches may also be performed depending on the implementation.

A second outward expanding search may be performed as represented by the band **3408***b*. During this second outward expanding search, a medical provider **3404***c* is identified. Once identified, brand information, location information, and gateway information are added to the batch **3402**. Thus,

as illustrated using a similar object fill, brand entity **404***b*, location entity **406***c*, and gateway entity **408***b* have been added to the batch **3402**. In this example, the medical provider **3404***c* is represented by the brand entity **404***b*, the location entity **406***c*, and the gateway entity **408***b*.

A third outward expanding search may be performed as represented by the band **3408***c*. During this third outward expanding search, a medical provider **3404***d* is identified. Once identified, brand information, location information, and gateway information are added to the batch **3402**. Thus, as illustrated using a similar object fill, brand entity **404***c* and location entity **406***d* have been added to the batch **3402**. Because the gateway entity **408***b* used by the medical provider **3404***d* had already been identified, a new gateway is not added to the batch **3402**. Instead, a relationship between the location entity **406***d* and the gateway entity **408***b* is created. In this example, the medical provider **3404***d* is represented by the brand entity **404***c*, the location entity **406***d*, and the gateway entity **408***b*.

A fourth outward expanding search may be performed as represented by the band **3408***d*. During this fourth outward expanding search, medical providers **3404***e*, **3404***f* are identified. Once identified, brand information, location information, and gateway information are added to the batch **3402**. Thus, as illustrated using a similar object fill, brand entity **404***d*, location entities **406***e*, **406***f*, and gateway entity **408***c* have been added to the batch **3402**. In this example, the medical provider **3404***e* is represented by the location entity **406***e* and the gateway entity **408***b*. The medical provider **3404***f* is represented by the brand entity **404***d*, the location entity **406***f*, and the gateway entity **408***c*.

FIG. **35** illustrates an example flow chart showing the process **3500** for enabling anonymized user searching of medical provider entities, according to at least one example. The process **3500** may be performed by the provider subscription system **112**

The process **3500** may begin at **3502** by generating a medical entity batch (e.g., the batch **3402**). In some examples, the batch may include a brand entity set, a location entity set, and a gateway entity set. Generating the medical entity batch may include, e.g., as discussed with respect to FIG. **34**, selecting a first location entity associated with a first geographic location, beginning, based at least in part on the first geographic location, an outward expanding geographic search for other entities, ceasing the outward expanding geographic search when a threshold number of entities has been identified for each of the brand entity set, the location entity set, and the gateway entity set.

In some examples, generating the entity batch is based at least in part on generating a plurality of other entity batches. In some examples, generating the plurality of other entity batches and the entity batch may include converting each entity identifier of each medical entity to an integer value in a range between one and a predefined number corresponding to a number of slots in each entity batch and assigning each medical entity to a respective entity batch based at least in part on the respective integer value, the respective integer value being equal to a respective batch identifier.

At **3504**, the process **3500** may include assigning a batch identifier to the medical entity batch. In some examples, individual entities in the medical entity batch may be associated with respective entity identifiers.

At **3506**, the process **3500** may include receiving a search query (e.g., from a user device). The search query may include one or more search terms.

At **3508**, the process **3500** may include providing search results including a list of medical entities. The list may be provided to the user device based at least in part on the one or more search terms.

At **3510**, the process **3500** may include receiving a request about a particular medical entity from the list of medical entities. This request may be received from the user device. The particular medical entity may belong to the medical entity batch. The request may include the batch identifier and a particular entity identifier identifying the particular medical entity.

At **3512**, the process **3500** may include providing the information about the particular medical entity together with other information about other entities in the medical entity batch to the user device. In some examples, providing the information about the particular medical entity together with other information about other medical entities in the entity batch obfuscates an identity of the particular medical entity.

In some examples, the process **3500** may further include receiving a second request from the user device for other information about the particular medical entity. The second request may include the batch identifier and the particular entity identifier.

In some examples, the threshold number of entities is a different value for each one of the brand entity set, the location entity set, and the gateway entity set.

In some examples, at least one gateway entity of the gateway entity set is associated with more than one location entity of the location entity set.

In some examples, a provider database is provided and configured to store information about the medical entities. In this example, the process **3500** may further include, after assigning the batch identifier, storing information about the medical entity batch in association with the batch identifier in the provider database.

In some examples, the process **3500** may further include enabling the user device to establish a connection with a gateway entity associated with the particular medical entity. In some examples, the information about the particular medical entity comprises configuration information associated with the gateway entity. The configuration information may be useable by the user device to make one or more predefined method calls to the gateway entity.

FIG. **36** illustrates an example flow chart showing the process **3600** for enabling anonymized user searching of medical provider entities, according to at least one example. The process **3600** may be performed by the user device **1400**.

The process **3600** may begin at **3602** by providing a search query to a server. The search query may include one or more search terms. A user may input the search terms using any suitable input means.

At **3604**, the process **3600** may include receiving search results including a minimum number of medical entities. In some examples, the search results may be received from a server (e.g., the provider subscription system **112**). The search results may be selected based at least in part on the one or more search terms. In some examples, each medical entity of the medical entities is associated with an entity identifier.

At **3606**, the process **3600** may include receiving user selection of a first medical entity from the minimum number of medical entities.

At **3608**, the process **3600** may include storing a first entity identifier associated the first medical entity in asso-

ciation with other entity identifiers associated with other medical entities from the minimum number of medical entities.

At **3608**, the process **3600** may include providing a request for information about the first medical entity. The request may be sent to the server and may include the first entity identifier and the other entity identifiers.

At **3610**, the process **3600** may include receiving the information about the first medical entity together with other information about the other medical entities. In some examples, this information may be received from the server and in response to providing the request. In some examples, receiving the information about the first medical entity together with the other information about other medical entities obfuscates, from the server, an identity of the first medical entity as the medical entity that was subject to the user selection.

In some examples, the process **3600** may further include establishing a connection with a gateway entity associated with the first medical entity.

In some examples, the information about the first medical entity includes configuration information associated with the gateway entity. The configuration information may be useable by the user device to make one or more predefined method calls to the gateway entity to establish the connection with the gateway.

In some examples, storing the first entity identifier associated the first medical entity in association with the other entity identifiers associated with other medical entities is performed at least during a period of time when the connection with the gateway exists.

FIG. **37** illustrates a block diagram **3700** depicting a server-based approach for managing user device access to a plurality of gateways of the EHR systems, according to at least one example. The diagram **3700** includes a server (e.g., the provider subscription system **112**), a user device operated by a user (e.g., the user device **104** and the user **106**), and a plurality of EHR systems **114***a*-**114***n* (e.g., gateways entities **408***a*-**408***n*). Using techniques described herein, a plurality of independent connections may be established between the user device **104** and the EHR systems **114***a*-**114***n*. Using these connections, the user device **104** may download electronic health record data for the user **106**. The EHR systems **114**, the provider subscription system **112**, and the user device **104** may all be operated by separate entities. In some examples, networking equipment at the EHR systems **114** may only be capable of handling a certain number of network request at any given time. Too many requests at any given time may cause the EHR systems **114** to malfunction or otherwise become unavailable. To address this concern, the provider subscription system **112** may manage when and how frequently the user **106** attempts to connect to the EHR systems **114**. Such management may be based on specific characteristics of the EHR systems **114** and/or may be based on generic characteristics shared by more than one EHR system **114**. For example, as part of adding the EHR systems **114** to the system operated by the provider subscription system **112**, network capability configuration information may be gathered from the EHR systems **114**. This information may later be used by the provider subscription system **112** to determine when and how frequently the user device **104** can contact the EHR systems **114**. In some examples, the provider subscription system **112** may estimate characteristics of the EHR systems **114** to make this determination, which may be based on an update value.

FIG. **38** illustrates an example flow chart showing the process **3800** for a server-based approach for managing access of a user device to a gateway entity, according to at least one example. The process **3800** may be performed by the provider subscription system **112**, the user device **104**, and/or the EHR system **114** (e.g., a gateway entity of the EHR system **114**).

The process **3800** may begin at **3802** by sending an information request for accessing a gateway. This may be performed by the user device **104**. The information request may be sent to a server (e.g., the provider subscription system **112**). The information request may request information about accessing the gateway of the EHR system **114**.

At **3804**, the process **3800** may include generating an update value based at least in part on the information request. This may be performed by the provider subscription system **112**. The update value may represent a time period (e.g., a hour, a day, a week, a month, etc.) and may be generated based at least in part on characteristics of the EHR system **114**. In some examples, the time period is expressed in seconds. Relevant characteristics of the EHR system **114** may include those that are related to network load capabilities of the EHR system **114**.

At **3806**, the process **3800** may include accessing a data object associated with the gateway of the EHR system **114**. This may be performed by the provider subscription system **112**. The data object may include configuration information useable by the user device **104** for accessing the gateway. For example, the configuration information may include application programming interface (API) information that is particular to the gateway. Later, the user device **104** may use the API information for connecting to the gateway of the EHR system **114** and downloading health record data. The data object may include a universal user identifier for the gateway.

At **3808**, the process **3800** may include providing the update value and the data object. This may be performed by the provider subscription system **112**. In some examples, the update value and the data object are provided to the user device **104** in response to the information request.

At **3810**, the process **3800** may include receiving the update value and the data object. This may be performed by the user device **104**. The update value and the data object may be received from the provider subscription system **112**.

At **3812**, the process **3800** may include determining a random clock value. This may be performed by the user device **104**. This may be performed by the user device **104**. The random clock value may be a value that is between zero and the update value. The random clock value may correspond to a clock time within the time period. For example, the update value may be 86,400 seconds, which corresponds to a period of one hour. Given a current clock time of, e.g., 13:22:00, a random clock value may be determined that is within 86,400 seconds of 13:22:00. For example, if the random clock value were determined to be 43,200 seconds, then the clock time may be 13:52:00, e.g., half an hour later. The clock time may be used to schedule future requests (e.g., access requests that request downloading) to the gateway of the EHR system **114**.

At **3814**, the process **3800** may include sending an access request to the gateway at a clock time corresponding to the clock value and in accordance with the data object. This may be performed by the user device **104**. The access request may request to download health record data maintained by the EHR system **114**. In some examples, the data object may store configuration information for accessing the gateway of the EHR system **114**. This configuration information may include API information, URLs, authentication information, etc.

At **3816**, the process **3800** may include receiving the access request. This may be performed by the EHR system **114**. Assuming that the access request was sent by the user device **104** at the clock time, the access request may be received by the EHR system **114** shortly after the clock time.

At **3818**, the process **3800** may include generating a data package including health record data. This may be performed by the EHR system **114**. The health record data may be generated using the Fast Healthcare Interoperability Resources (FHIR) standard or any other suitable standard such as those promulgated by the HL7 standard body and/or other standard bodies.

At **3820**, the process **3800** may include sending the data package in accordance with the request. This may be performed by the EHR system **114**. Sending the data package may include sending the data package to the user device **104**. As described herein, the user device **104** may be associated with a user (e.g., a patient) to whom the health record data belongs.

At **3822**, the process **3800** may include storing a portion of the health record data. This may be performed by the user device **104**. The user device **104** may store the health record data in any suitable format. Part of storing the health record data may include indexing medical terms from the health record.

In some examples, the process **3800** may further include sending an additional information request from the user device **104** and to the provider subscription system **112** in preparation for sending an additional access request to the gateway of the EHR system **114**. In this example, the process **3800** may further include receiving an additional communication from the provider subscription system **112**. The additional communication may include a status indicator for the gateway. When the status indicator indicates that the gateway is available, the user device **104** may send additional access requests to the gateway of the EHR system **114**. When the status indicator indicates that the gateway is unavailable, the user device **104** may refrain from sending the additional access requests.

FIG. **39** illustrates an example flow chart showing the process **3900** for a user-device based approach for managing access to a gateway entity, according to at least one example. The process **3900** may be performed by the provider subscription system **112** and the user device **104**.

The process **3900** may begin at **3902** by sending an information request for accessing a gateway, e.g., of the EHR system **114**. This may be performed by the user device **104**. The request may be sent to a server, e.g., the provider subscription system **112**. The information request may request information about accessing a gateway of an electronic health record system, e.g., the EHR system **114**. In some examples, the information request includes information identifying a medical provider associated with the EHR system **114** and a plurality of other medical providers associated with at least one of the EHR system **114** or a different EHR system.

At **3904**, the process **3900** may include accessing a data object associated with the gateway, e.g., of the EHR system **114**. The data object may include access information and configuration information for the gateway.

At **3906**, the process **3900** may include providing the data object. This may be performed by the provider subscription system **112**. Providing the data object may include providing the data object to the user device **104**.

At **3908**, the process **3900** may include receiving the data object. This may be performed by the user device **104**. The data object may be received in a communication from the provider subscription system **112**. The configuration information may be useable by the user device **104** for accessing the gateway. For example, the configuration information may include application programming interface (API) information that is particular to the gateway.

At **3910**, the process **3900** may include sending a first access request for health record data. This may be performed by the user device **104**. The first access request may be sent to the provider subscription system **112**. The first access request may, in particular, request downloading of health record data for a user of the user device **104** that is maintained by the EHR system **114**.

At **3912**, the process **3900** may determine whether the download was successful. This may include determining whether the user device **104** was able to connect to the gateway and/or whether the user device **104** received the requested health record data. In some examples, this may be based at least in part on receiving a connection timeout error from the gateway.

If the answer at **3912** is YES, the process **3900** proceeds to **3914** at which the process **3900** may include storing a portion of the health record data. In some examples, this may be performed by the user device **104**. The user device may store the portion of the health record data using a first data model. Storing the portion of the health record data may include receiving a FHIR data package, unpacking the data, and storing the data.

If the answer at **3912** is NO, the process **3900** proceeds to **3916** at which the process **3900** may include determining a future time to send a next access request. This may be performed by the user device **104**. The second access request may be an access request to be sent to the gateway. This determination may be based on a predefined route available on the user device **104**. For example, the predefined routine may be configured to determine the conditions under which the user device **104** can attempt to connect to the gateway and/or other remote devices. In some examples, determining the future time may be based at least in part on characteristics of the user device. For example, the characteristics of the user device may include at least one of locked state, battery life, network connectivity, available processing capabilities, available storage, and/or any other suitable characteristic.

At **3918**, the process **3900** may including sending the next access request. This may be performed by the user device **104**. Sending the next access request may include sending to the gateway at the future time determined at **3916**.

In some examples, the process **3900** may further include sending an additional information request to the provider subscription system **112** in preparation for sending an additional access request to the gateway. In this example, the process **3900** may further include receiving an additional communication from the provider subscription system **112**. The additional communication may include a status indicator for the gateway. In this example, the process **3900** may further include refraining from sending the additional access request when the status indicator indicates that the gateway is unavailable. In this manner, the user device **104** may check in with the provider subscription system **112** to obtain updated status information for the gateway. This may minimize the situation in which the user device **104** attempts to contact the gateway, but cannot obtain information because the gateway is unavailable. If the gateway is available, then the user device **104** may contact the gateway.

FIG. **40** illustrates an example flow chart showing the process **4000** for simulating user connections to gateways of electronic health record systems, according to at least one

example. The process **4000** may be performed by the provider subscription system **112**.

The process **4000** may begin at **4002** by simulating user connections to a plurality of gateways. The simulation may be performed during a first period. The plurality of gateways may be associated with a plurality of electronic health record systems configured to maintain electronic health records for a plurality of users (e.g., patients). In some examples, simulating the user connections to the plurality of gateways may include using test user credentials to connect to test user profiles maintained by the plurality of EHR systems. The process **4000** may also include texting the gateway.

At **4004**, the process **4000** may include determining a simulation condition of a first user connection to a first gateway of the plurality of gateways. The simulation condition may be identified while simulating the user connections to the plurality of gateways at **4002**. The simulation condition includes at least one of a partial failure condition, a complete failure condition, or a success condition.

At **4006**, the process **4000** may include performing a first action when the simulation condition indicates a partial failure. The first action may include simulating a second user connection to the first gateway during a second period. The first action may also include determining that the first gateway is inactive based at least in part on the second user connection failing during the second period. The first action may also include notifying a set of user devices that the first gateway is inactive. For example, the provider subscription system **112** may maintain a registry of user devices that maintain connections to the first gateway. Using this registry, the provider subscription system **112** may send a status message to the user devices. In some examples, the notifying the user devices may include publishing a status of the first gateway to a network location accessible by the user devices. For example, the provider subscription system **112** may update a record in the provider database **118** in which the information about the first gateway is saved. When the user devices "check in" with the provider subscription system **112** prior to connecting to the first gateway, the provider subscription system **112** can share the updated status information.

At **4008**, the process **4000** may include performing a second action when the simulation condition indicates a complete failure. In this example, the second action may include notifying the set of user devices that the first gateway is inactive without simulating the second user connection. For example, the simulation condition may be so severe that the user devices should not even try to connect to the first gateway. Notifying the set of user devices may be performed as discussed with reference to block **4006**.

At **4010**, the process **4000** may include performing a third action when the simulation condition indicates a success. In this example, the third action may include enabling the set of user devices to connect to the first gateway. This may include updating an availability status of the gateway and allowing the user devices to access the availability status. In some examples, the third action may include enabling the set of user devices to connect to the first gateway in accordance with an update value. The update value may be defined as a future time window in which the set of user devices randomly connect to the first gateway.

FIG. **41** illustrates a block diagram **4102** and a flow chart illustrating the process **4100** for indexing medical terms from an electronic health record, according to at least one example. The block diagram **4102** may include the user device **104**, the EHR system **114**, and the terminology management system **130**. In some examples, the terminology management system **130** performs at least a portion of the process **4100**. For example, the terminology management system **130** may index terms in a similar manner as the user device **104**. In some examples, the terminology management system **130** may obtain access to many electronic health records (e.g., from a clinical data warehouse or other storage location). Using the electronic health records, the terminology management system **130** can build the term base **132**.

The process **4100** may begin at **4104** by downloading a data package including health record data from a gateway of the EHR system **114**. This may be performed by the user device **104**. The health record data may be in any suitable format including, for example, the FHIR® standard, Clinical Documentation Architecture (CDA®), other standards promulgated by the Argonaut® project, or any other suitable standard. The health record data may include a personal electronic health record of a patient associated with a medical provider that is associated with the EHR system **114**. In some examples, the personal electronic health record represents a portion of the user's **106** personal health record. Downloading the data package may include storing the electronic health record data according to a first data model.

At **4106**, the process **4100** may include indexing medical terms in the health record data. This may be performed by the user device **104**. The medical terms may be text in the health record data that describes aspects of the user's **106** health. For example, the medical terms may be text strings that describe a visit to a doctor, a prescription, results from a lab test, results from an imagery test, vital sign data, and any other suitable structure or unstructured data item from the electronic health record. As an additional example, the medical terms may be industry standard codes (e.g., RxNorm™, LOINC®, SNOMED™, and other suitable standard codes). Indexing the medical terms may include generating a medical term expression for the medical terms. The medical term expression is composed of medical term primitives that represent parts of the medical term. When a medical term is indexed, the corresponding medical term expression can be saved off and used for many different purposes described herein. Other information can be saved off that allows reproduction of the original medical term based on the medical term expression. Indexing medical terms will be described in more detail herein (e.g., FIG. **43-44**). In some examples, the medical term expression may be generated using an industry standard code

At **4108**, the process **4100** may include determining whether the medical terms are indexable. This may be performed by the user device **104**. A term is indexable if the user device can generate a medical term expression for the medical term. If medical terms are unidexable, at **4110**, the process **4100** may include uploading the unidexable medical terms for resolution. This may include uploading the unidexable medical terms to the terminology management system **130**. Receipt of the unidexable medical terms by the terminology management system **130** may trigger a workflow for resolving the medical terms. This workflow may include presenting the medical terms to medical professionals to determine a meaning for each of the medical terms. In some examples, the medical professionals may compare the medical terms with the proposed indexed terms to see if an association is improper.

Once the terminology management system **130** has resolved the unidexable medical terms, these terms may be send to the user device **104** using the updater service **204**. For example, the updater service **204** may send the resolved terms as an over-the-air update to the user device **104**. The

user device **204** may then add the resolved terms to the term base **214**. In some examples, the resolved terms may be provided to the user device **104** as part of an operating system update. In this example, the user may perform some action to initiate the operating system update. In the over-the-air update example, the updates may happen in the background when certain device conditions are met (e.g., connected to a WiFi network, plugged in, etc.), but without the user having to perform an action.

If the term is indexable, the process **4100** may proceed to **4112**, at which, the process **4100** may include computing scores for the indexed medical terms. This may be performed by the user device **104** as part of a finalization process. The scores may represent how well the terms were indexed. The scores may include a completion score representing how well a particular medical term corresponds to an ideal medical term. The completion score may be based at least in part on a medical category to which the indexed medical term belongs. The scores may also include a coverage score representing a ratio of how much of the particular medical term was indexed (e.g., 75% of the words from the particular medical term are represented by the indexed medical term). The scores for the indexed medical terms may be shared with the terminology management system **130**.

At **4114**, the process **4100** may include storing the indexed medical terms. This may be performed by the user device **104**. The indexed terms may be stored in a term base according to a second data model that is different from the first data model.

At **4116**, the process **4100** may include using the indexed medical terms to present medical information. This may be performed by the user device **104**. This may include presenting the medical information in a uniform or otherwise normalized manner, sorting and organizing a personal health record, searching other databases for medical data, supplementing the personal health record with metadata that enhances the user experience of interacting with her personal health record. For example, medical terms that are sourced from many different medical providers can be indexed. To achieve uniformity in how the data is organized and presented, the indexed medical terms can be used. Doing so essentially allows the user device **104** to compare raw medical terms from the different medical providers to determine that the medical providers are referring to the same thing, even though they may be using different language.

FIG. **42** illustrates a block diagram **4200** depicting the user device **104** useable for indexing medical terms from an electronic health record, according to at least one example. As introduced herein, the user device **104** may include the health application **212** and the term base **214**. The health application **212** may include an indexing engine **4202** that includes a plurality of components **4202-4214**. Generally, the indexing engine **4202** may include an indexing algorithm adapted to achieve the function described herein. The function of these components will be discussed with reference to a flow chart and associated depictions in FIGS. **43** and **44**. The flow chart in FIGS. **43** and **44** shows the process **4300** relating to indexing medical terms, according to at least one example.

The indexing engine **4202** operates with respect to an information model including a plurality of data types including, for example, medical topics, medical categories, items, and synonyms. In addition, metadata may be associated with medical terms using three different data types including, for example, classifications, facts, and expressions.

A medical topic, sometimes referred to as a medical grammar, may define the data characteristics (e.g., medical categories) that are unique to a particular medical topic. Examples of medical topics include, for example, allergies, conditions, immunizations, labs, medications, procedures, units, vitals, and other similar descriptive medical topics.

A medical category is a classification of a quantifiable value that may be extracted from a term and is associated with one or more categories. Thus, a medical category further defines a medical topic. Examples medical categories for the medical topics of allergies, conditions, immunizations, labs, medications, procedures, units, and vitals are presented below respectively in Tables 1, 2, 3, 4, 5, 6, 7, and 8. Examples of the medical categories are also shown below. For example, "hypersensitivity to" is an example of a medical category of "disposition" in the medical topic of "Allergies" shown in Table 1.

TABLE 1

Medical Topic: Allergies

Medical Category	Example
disposition	"hypersensitivity to"
substance	"Dog hair"
reaction	"hives"
severity	"mild"
ignore	"allergy"

TABLE 2

Medical Topic: Conditions

Medical Category	Example
bodySite	"breast"
bodySystemOrRegion	"genitourinal"
finding	"Fracture"
laterality	"left"
position	"top"
observable	"Glucose tolerance test"
organism	"Leucocytozoon"
substance	"1,3-beta-glucan synthase"
process	"Sting", "Life event"
physicalForce	"Gravity"
procedure	"Hysterectomy"
device	"Pacemaker battery"
category	"First degree"
findingQualifier	"Unruptured"
course	"Chronic"
severity	"Severe"
occurrence	"Congenital"
ignore	"(disorder)", "of", "for"

TABLE 3

Medical Topic: Immunizations

Medical Category	Example
brandName	"Fluvax"
vaccine	"Influenza"
formulation	"adjuvant", "2015-16"
route	"Nasal"
ageRange	"adolescent", ">10 years old"
ignore	"dialysis"

TABLE 4

Medical Topic: Labs

Medical Category	Example
analyte	"Advil"
analyteQualifier	"Ibuprofen"
analyteSubQualifier	"150 MG"
challenge	"20M post collection"
adjustment	"corrected for albumin"
property	"Number fraction"
timeAspect	"Point in time"
specimen	"urine"
bodySite	"cervix"
valueType	"Quantitative"
method	"Agar diffusion"
ignore	"Result", "see emr for details"

TABLE 5

Medical Topic: Medications

Medical Category	Example
brandName	"Advil"
ingredient	"Ibuprofen"
strength	"150 MG"
route	"Oral"
doseForm	"Tablet"
doseFormQualifier	"Extended Release"
releasePeriod	"12 HR"
ignore	"(bulk)", "(USP)"

TABLE 6

Medical Topic: Procedures

Medical Category	Example
procedure	"EKG"
device	"Pacemaker"
substance	

TABLE 7

Medical Topic: Units

Medical Category	Example
unit	"mg/ml"

TABLE 8

Medical Topic: Vitals

Medical Category	Example
vital	"Heart rate"
ignore	"oral"

A medical data item may be a quantifiable value that may be extracted from a medical item (e.g., for the brand name category in a medication topic, medical items may include Motrin, Advil, Tylenol, etc.). Thus, medical data items may be grouped by the medical category to which they belong. Medical data items may always be unique to their associated category. In some examples, medical data items may represent the most precise way to describe the quantifiable value it represents, which often is not an abbreviation or synonym. In the event that a symbol associated with a medical data item is valid for multiple medical categories (e.g., Motrin), a unique medical item with the same symbol could exist in all relevant medical categories.

A synonym may be a quantifiable value that is an alternative to its corresponding medical item (e.g., "Mot." may be a synonym to "Motrin"). Synonyms may be associated with a specific medical item, in the event that the symbol (e.g., Mot.) associated with the synonym is valid for multiple medical items and/or medical categories. In some examples, a unique synonym with the same symbol may exist within all relevant medical items and/or medical categories.

In addition to the core ontology from above, metadata may be associated with medical terms using three different data types including, for example, classifications, facts, and expressions. A classification may define a predicate (e.g., classification [pain reliever, anti-inflammatory, cancer drug], color, usage/directions, etc.). A fact may be a Web Ontology Language (OWL) triple and that associates classification, medical term expressions, and a value. An expression specifies a medical term (e.g., Motrin 200 Mg Oral Tablet) as an index (e.g., [100, 101, 102, 2000]. The techniques described herein relate to converting medical terms to expressions and using those expressions to perform various other operations.

In some examples, another data type is used for indexing. For example, a rule describes a context-specific operation to be performed during the indexing process. Rules are often scoped to a medical topic, and sub-scoped to a medical category. In this manner, a rule may be triggered for a specific medical topic and medical category, but not for other topic/category combinations. Using rules may allow the indexing engine **4202** to produce customized results. In some examples, the rules contain both a scope and sub-scope, an evaluation order (in the event that multiple rules are defined for a step/phase), as well as operation-specific parameters.

Generally, the indexing engine **4202** may be configured to implement a process of transforming raw medical terms into quantifiable values (e.g., medical term expressions including expression primitives) that are well suited for storage in a database. These quantifiable values may be queried and/or otherwise manipulated in a manner that produces unique benefits for the users of this technology. The output from the indexing engine **4202** after indexing a raw medical term may include a term index for the medical term and an accompanying data structure that describes in detail each medical category, medical data item, synonyms, etc. that were identified in the raw medical term. The term index is a fingerprint of the medical term referred to as a term expression. The term expression is made up of multiple expression primitives that each map to a medical data item or synonym of a medical data item in the term base. In this manner, the term index represents the raw medical term.

Two raw medical terms that result in the same medical term expression may be considered equivalent even though the structure and content of each of the medical terms is different. For example, indexing the terms "Motrin 200 mg Oral Tablet" and "mot. or. tab. 200 mg" using the indexing engine **4202** will produce the same medical term expressions and are therefore equivalent even though they are visibly different. The more information extracted from the medical term, the longer the medical term expression will be. For example, "Motrin Ibuprofen 200 mg Oral Tablet" will have a longer medical term expression than the example above because Ibuprofen maps to an ingredient (e.g., a medical category) in the medications topic (e.g., a medical topic).

The plurality of components **4202-4214** may include a parsing component **4204**, a tokenizing component **4206**, a syntactic component **4208**, a semantic component **4210**, an assembly component **4212**, and a finalization component **4214**. Generally, the process of indexing medical terms may include pre-processing, in-processing, and post-processing. For example, at any of these stages, rules, as described herein, may be implemented to alter the stage. Because the rules may be applied in the data, they may be applied in an efficient and agile manner. New rule types may be added at any time, without impacting the underlying algorithm that constitutes the plurality of components **4202-4214**. For example, when a new pattern is recognized in multiple medical records or something is not displaying correctly, a new rule type may be added at any point in the processes described below to adjust the indexing of the medical terms.

As illustrated in FIG. **43**, the process **4300** may begin at **4304** by using the parsing component **4204**. This may be performed by the indexing engine **4202**. The parsing component **4204** may be configured to extract and parse raw, original medical terms from health record data (e.g., a FHIR data package including an electronic health record). For example, the parsing component **4204** may parse a raw medical term **4306**. This parsing subdivides the medical term **4360** into a plurality of individual words, referred to as medical data sections **4308** or more simply sections.

Rules applied at this stage may focus on string manipulation. For example, the rules may adjust the order of the words in the string, ignore certain words, etc. In some examples, the rules may include pre-processing delimiting rules. These rules may set topic-specific delimiters to be used to split the raw medical delimiters. The topic-specific delimiters may be used to split the raw medical term **4306** into the individual medical data sections **4308**. In some examples, the rules may include pre-processing replacing rules. These rules may define a regular expression that is used to replace content in the raw medical term **4306** with other content. In some examples, this rule may result in simplified processing downstream since it can be used to normalize otherwise complex character sequences.

At **4310**, the process **4300** may include using the tokenizing component **4206**. This may be performed by the indexing engine **4202**. The tokening component **4206** may be configured to transform the medical data sections **4308** into a plurality of composite medical data sections **4312** or simply composite sections. The plurality of composite medical data sections **4312** include the medical data sections **4308** and possible combinations of multiword sequences of medical data sections **4308** found in the raw medical term **4306**.

Rules applied at this stage may focus on manipulation of the composite medical data sections **4312**. For example, the rules may adjust multiword sequences, add and/or remove certain words, and cause other changes to the composite medical data sections **4312**. In some examples, the rules may include post-processing expanding rules. These rules may be used to identify and add composite medical data sections **4312** that are based on existing composite medical data sections **4312** that have been expanded to include leading and trailing delimiters characters. In some examples, the purpose of this rule may be to accommodate the storage of medical data items in the term base that include this punctuation. In some examples, the rules may include post-processing replacing rules. These rules may be used to identify and add new composite medical data sections **4312** that are based on existing composite medical data sections **4312** that have been transformed to exclude text that matches a certain pattern.

At **4314**, the process **4300** may include using the syntactic component **4314**. This may be performed by the indexing engine **4202**. The syntactic component **4314** may be configured to identify candidate medical data items and synonyms present in the raw medical term **4306** (e.g., Motrin, 200 MG, Tablet, Oral). In table **4316**, these medical data items are presented together with other information about the identified sections. For example, the table **4316** may include the raw sections from the raw medical term **4306** (e.g., motrin, 200 mg, tablet, oral), a medical category assigned to each raw section (e.g., brand, ingredient, strength, dose form, route), a position of the raw section in the raw medical term **4306** (e.g., 0-5, 7-12, 14-19, and 21-24). The candidate medical data items and synonyms may be represented as item descriptors.

Rules applied at this stage may focus on inclusion and/or exclusion of additional medical categories and adding, changing, and/or removing item descriptors. In some examples, the rules may include pre-processing rules based on medical categories. These rules may be used to specify additional categories to be used when searching for medical data items and/or synonyms.

At **4318**, the process **4300** may include using the semantic component **4210**. This may be performed by the indexing engine **4202**. The semantic component **4210** may be configured to determine which item descriptors (e.g., items and synonyms) should be included in a uniform medical term **4320** (e.g., Motrin, 200 MG, Tablet, Oral). In this example, the semantic component **4210** identifies the same item descriptors to be included in the uniform medical term **4320** because there were no overlapping words or phrases identified.

The semantic component **4210** may also configured to determine the best combination of item descriptors based on rules. For example, a rule may define what are the necessary elements to fully define a medication (e.g., brand, ingredient, strength, dose form, and route). The rules may indicate when brand names should be replaced by generic names or ingredients, and may indicate any other suitable distinction.

In some examples, the rules may include pre-processing relating to uncategorized medical data sections. These rules may include adding item descriptors that have no corresponding medical category. For example, this may mean that the word/phrase was not in the term base/database. This may affect scoring of the indexed term.

In some examples, the rules may include pre-processing that removes overlaps by category. These rules may function to remove large item descriptors that overlap a smaller expression primitive and for which another alternative, smaller item descriptors, which occupies the same part of the raw term and has the same medical category, exists.

In some examples, the rules may include pre-processing rules that remove overlaps by size. These rules may function to remove overlapping item descriptors from the list of item descriptors extracted from the raw medical terms. An item descriptor may overlap another item descriptor if any part of the text occupies the same location within the medical term expression.

At **4324**, the process **4300** may include using the assembly component **4212**. This may be performed by the indexing engine **4202**. The assembly component **4212** may be configured to generate expression primitives **4326** that correspond to each of the medical data items (e.g., item descriptors) identified previously. For example, the expres-

sion primitive for "Motrin" may be "3218", for 200 MG "8875", and so on and so forth. The assembly component **4212** may also be configured to generate a medical term expression **4328** that includes the expression primitives **4326** and corresponds to the uniform medical term **4320**. The medical term expression **4328** may function as a parse tree that represents the uniform medical term **4320**.

Rules applied at this stage may focus on altering the parse tree. In some examples, the rules may include in-processing rules to exclude categories. The item descriptors may be associated with the medical categories from the medical term expression **4328**.

In some examples, the rules may include pre-processing rules to group items. For example, these rules may group item descriptors in the parse tree. For example, grouping may be used to explicitly group ingredient and strength within a medications medical term expression. In some examples, these rules may be used to create parse trees containing multiple, separate medical topics (e.g., notes entered by a doctor or nurse may be indexed, resulting in multiple types of data, including diagnosis and treatment).

In some examples, the rules may include post-processing sorting. These rules may sort the parse tree by medical category and position. For example, this rule may be used to order the term index so that the more important medical categories are first in the term index.

At **4330**, the process **4300** may include using the finalization component **4214**. This may be performed by the indexing engine **4202**. The finalization component **4214** may be configured to generate additional information from the data contained in the parse tree generated at **4324**. In this example, this additional information may include the uniform medical term **4320**, a term identifier **4332**, and one or more scores. In some examples, the scores **4334** may include a coverage score and a completion score. The coverage score may represent how much of the raw medical term **4306** was indexed. In this example, the coverage score may be 100 because the entire raw medical term **4306** is represented by the medical term expression **4328** and the uniform medical term **4320**. The completion score may represent how complete the uniform medical term **4320** is compared to a defined complete score. In this example, the completion score may be 100 because the medical term expression **4328** and the uniform medical term **4320** include the necessary components of a medication.

As described herein, the indexing engine **4202** may be used to quantify/fingerprint raw medical terms extracted from health records downloaded on to user devices. The term index associated with these terms may be stored in the health application **212** and/or the term base **214**. In some examples, the term index can be stored in other locations such as a database associated with the health application **212**. Information from this database can be accessed by first and third party applications. The indexing engine **4202** may identify and remove personally identifiable information (PII) from raw terms explicitly sent by user devices to a server. In some examples, the indexing engine **4202** may combine the term index with term base metadata. This information can be exposed to APIs to allow digital assistants to convey health care related information to users. In some examples, the indexing engine **4202** can be used in other domains where users ask questions that need to be precisely interpreted in a context-sensitive manner and for which additional fact and/or metadata is often available that will enrich the result of the query.

FIG. **45** illustrates an example flow chart showing the process **4500** for indexing medical terms from an electronic health record, according to at least one example. The process **4500** may be performed by the user device **104**. In some examples, the provider subscription system **112** may perform the process **4500**.

The process **4500** may begin at **4502** by accessing a medical term from an electronic health record. The electronic health record may be stored on a user device.

At **4504**, the process **4500** may include indexing the medical term using a term base to generate a medical term expression. In some examples, indexing the medical term may include parsing the medical term to identify one or more medical data sections present in the medical term. Each medical data section may represent a constitute part of the medical term. In some examples, indexing the medical term may include assigning the one or more medical data sections to one or more medical categories of a plurality of medical categories represented in the term base. In some examples, each medical category may include a logical grouping of the medical data sections. In some examples, indexing the medical term may include generating a medical term expression comprising one or more expression primitives based at least in part on information associated with the one or more medical categories. The medical term expression may be useable for generating a uniform medical term corresponding to the medical term.

At **4506**, the process **4500** may include storing the medical term expression on the user device. In some examples, the term base may be stored on the user device. In this example, storing the medical term expression on the user device may include storing the medical term expression in the term base.

In some examples, the medical term expression may constitute a term index for accessing the term base.

In some examples, the medical term expression may include a computer-quantifiable expression.

In some examples, the process **4500** may further include determining one or more uniform item descriptors corresponding to the one or more medical data items sections based at least in part on the one or more medical categories. In this example, generating the one or more expression primitives may be based at least in part on the one or more uniform item descriptors.

In some examples, the process **4500** may further include receiving, by the user device and from an endpoint of an electronic health record system, a data package including the electronic health record.

In some examples, the process **4500** may further include a computing completion score representing a completeness of the medical term expression based at least in part on a medical category to which the medical term expression belongs.

In some examples, the process **4500** may further include computing a coverage score representing a ratio of the one or more medical data items sections with respect to the one or more expression primitives. In this example, the process **4500** may further include sending information about the medical term expression to a terminology management system when the coverage score falls below a coverage threshold. The terminology management system may be configured to resolve the term and improve future indexing.

FIG. **46** illustrates an example flow chart showing the process **4600** for indexing medical terms from an electronic health record, according to at least one example. The process **4600** may be performed by the user device **104**. In some examples, the provider subscription system **112** may perform the process **4600**.

The process **4600** may begin at **4602** by receiving a data package including an electronic health record. The electronic health record may include raw medical data. Receiving may be by a user device and from a gateway of an electronic health record system.

At **4604**, the process **4600** may include storing the electronic health record on the user device according to a first data model.

At **4606**, the process **4600** may include extracting raw medical terms from the raw health data. In some examples, each raw medical term may include a text string.

At **4608**, the process **4600** may include decomposing a raw medical term of the raw medical terms into a plurality of medical data sections present in the raw medical term.

At **4610**, the process **4600** may include determining a medical topic to which the raw medical term belongs. In some examples, the medical topic may include a plurality of medical categories.

At **4612**, the process **4600** may include, for a medical data section of the plurality of medical data sections, assigning the medical data section to a medical category of plurality of medical categories based at least in part on a comparison of the medical data item with other medical data items represented in the medical category.

At **4614**, the process **4600** may include determining a uniform item descriptor corresponding to the medical data item based at least in part on the medical category.

At **4616**, the process **4600** may include generating an expression primitive for the medical data item based at least in part on the uniform item descriptor.

At **4618**, the process **4600** may include generating a medical term expression. In some examples, this may be based at least in part on the expression primitive. The medical term expression may represent the raw medical term in a quantifiable format and may be formed from the expression primitive and a plurality of other expression primitives.

In some examples, the expression primitive may be a term base identifier representing terms stored in a term base on the user device. The medical term expression may be a medical term index comprising more than one term base identifier.

At **4620**, the process **4600** may include storing the medical term expression on the user device according to a second data model. The second data model may distinct from the first data model.

In some examples, the process **4600** may further include generating a data structure that associates constitute parts of the raw medical term with the medical term expression. The data structure may be useable to reproduce the raw medical term from the medical term expression.

In some examples, the process **4600** may further include tokenizing the plurality of medical data sections to create a plurality of composite medical data sections representing sequence groupings of the plurality of medical data sections. In this example, the process **4600** may further include generating the medical term expression based at least in part on the plurality of composite medical data sections.

In some examples, the process **4600** may further include using the medical term expression to generate a uniform medical term corresponding to the raw medical term.

In some examples, the second data model may include a relational graph.

In some examples, the process **4600** may further include identifying a plurality of item descriptors present in the medical category. In this example, each item descriptor may correspond to a section.

In some examples, the plurality of other expression primitives correspond to at least some of the medical data items sections of the plurality of medical data sections.

FIG. **47** illustrates an example flow chart showing the process **4700** for removing personally identifying information using an indexing engine, according to at least one example. The process **4700** may be performed by the provider subscription system **112** or other suitable system. In some examples, the user device **104** may perform the process **4700**.

The process **4700** may begin at **4702** by receiving a first medical term from a user device. The first medical term may include personally identifying information that identifies a user (e.g., a user of the user device or other suitable user).

In some examples, receiving the first medical term from the user device may include receiving the first medical term in connection with other medical terms found in an electronic health record stored on the user device and associated with the user.

At **4704**, the process **4700** may include indexing the first medical term using a first term base. In some examples, indexing may be performed by at least parsing the first medical term to identify a medical data section present in the first medical term. The medical data section may describe a medical aspect of the first medical term.

At **4706**, the process **4700** may include removing the medical data section from the first medical term.

At **4708**, the process **4700** may include indexing the first medical term using a second term base. In some examples, this may be performed by at least parsing the first medical term to identify an identifying data section present in the first medical term. The identifying data section may include a portion of the personally identifying information.

At **4710**, the process **4700** may include generating a term expression that represents the first medical term in a computational form. The term expression may include a medical term primitive corresponding to the medical data section and an identifying primitive corresponding to the identifying data section.

In some examples, generating the term expression may include assigning the medical data sections and the identifying data section to one or more categories. In this example, generating the term expression may further include generating the medical term primitive and the identifying primitive based at least in part on the one or more categories.

At **4712**, the process **4700** may include generating a second medical term that includes deidentified information in place of the identifying data item. This may be performed based at least in part on the term expression.

At **4714**, the process **4700** may include using the second medical term in place of the first medical term.

In some examples, the medical term primitive is a first term base identifier corresponding to the first term base. In some examples, the identifying primitive is a second term base identifier corresponding to the second term base. In some examples, the term expression is a term index comprising the first term base identifier and the second term base identifier.

FIG. **48** illustrates a block diagram **4802** and a flow chart showing the process **4800** for enhancing a health record using indexed medical terms, according to at least one example. The block diagram **4802** includes the user device **104** and the EHR system **114**. The process **4800** may be performed by the user device **104**.

The process **4800** may begin at **4804** by downloading a data package including a health record from a gateway. The

gateway may be associated with the EHR system **114**. In some examples, the health record may be associated with the user **106**.

At **4806**, the process **4800** may include storing the health record using a first data model. The first data model may be a model configured to store the health record more or less in its raw form. For example, the data package may be downloading using the FHIR standard in XML, JSON, Turtle, or any other suitable format. The first data model may correspond to the FHIR standard data model that relies on four categories of data types: simple/primitive types (e.g., single elements with a primitive value), general purpose complex types (e.g., reusable clusters of elements), complex data types for metadata, and special purpose data types (e.g., reference, narrative, extension, meta, and dosage).

At **4808**, the process **4800** may include indexing medical terms present in the health record. This may include generating medical term expressions (e.g., term indexes) for each of the medical terms. Examples of this process are discussed with reference to FIGS. **41-47**.

In some examples, an on-device term base is provided in which the medical term expressions are stored. The on-device term based may be prepopulated with a first number of medical concepts. For example, the top one thousand medical concepts may be added to the on-device term base when the user device **104** first ships, as part of an operating system update, or over the air. In this way, the on-device term base is prepopulated with relationships between medical terms. This may be considered a generic or base relational graph. As the medical terms are indexed as described herein, they are added to this base relational graph, which begins to transform the base relational graph into a personalized relational graph that is unique to the user **106**. Over time the personalized relational graph is able to not only represent the user's **106** electronic health record, but may do so in a way that provides additional insights into the electronic health record that would be impossible by the user **106** simply viewing her record using a patient portal. For example, as described at **4810**, metadata may be added to the record that enhances the base relational graph. Similarly, additional medical concepts can be downloaded, when requested and/or as pushed updates, from a Cloud-based service such as the terminology management service **130** and/or the provider subscription system **112**. Storing the personalized relational graph on the user device **104** may be desirable as given that the overall relational graph from the other term base may be much too large to store on the device.

At **4810**, the process **4800** may include associating metadata with the indexed medical terms. In some examples, the metadata may be obtained from the provider subscription system **112**, the terminology management system **130**, or may be local to the user device **104**. The metadata may be associated with the indexed medical terms in a manner that enables efficient assembly of user interface elements relating to the indexed medical terms. The type of metadata may depend on the medical topic to which an indexed medical term belongs. For example, if the medical topic were medication, example metadata may include images of medication, general dosage instructions, chemical ingredients, color, links to information about the medication, a link to and/or image of a prescription relating to the medication, and any other suitable information. This metadata may be tagged or otherwise identified as being relevant to the indexed medical terms.

At **4812**, the process **4800** may include storing the indexed medical terms in association with the metadata using a second data model. This data may be stored in the term base on the user device **104**. In some examples, the indexed medical terms are stored in their indexed form (e.g., as medical term expressions) and the metadata is also stored therewith.

At **4814**, the process **4800** may include using an indexed medical term to identify particular entries in the health record. The indexed medical term used at **4814** may correspond to one of the medical terms from the health record. In this example, the indexed medical term may be used to filter, sort, or otherwise organize the health record based on the indexed medical term. For example, a user may select the indexed term "beta blocker" from a list of medication types. This selection may identify all entries in the health record relating to beta blocker by searching for beta blockers in the term base. In particular, this search will be performed by searching medical term expressions in the term base, instead of searching in the raw health record data. The entries may be pulled from instances of the user's **106** electronic health record that were downloaded to the user device **104** from multiple disparate sources (e.g., different gateways of the EHR systems **114**).

The indexed medical term used at **4814** may also correspond to a new search term input by the user **106**. For example, a user interface may be provided to allow the user **106** to search her electronic health record (e.g., one or more instances of her electronic health record that have been downloaded to the user device **104** from multiple different gateways of the EHR systems **114**). Such queries may be indexed using the techniques described herein to generate a search term expression. The search term expression may then be used to easily identify any medical terms expressions that include primitives similar to those in the search term expression. In this manner, such searching is performed in the term base without necessarily having to access the raw version of the electronic health record that is also saved on the user device **104**. In some examples, searching the medical term expressions may prove more efficient than conventional searching methods.

FIG. **49** illustrates an example diagram depicting a relational graph **4900** relating to the medical term expression **4328** from FIG. **44**, according to at least one example. The relational graph **4900** may correspond to the medication type medical topic. The relational graph **4900** may include medical term expression primary node **4902**. The primary node **4902** may represent the term identifier **4332** that represents the medical term expression **4328**. Sub-nodes **4904***a*-**4904***d* may be associated with the primary node **4902**. The sub-nodes **4904***a*-**4904***d* represent the expression primitives **4326** of the medical term expression **4328**. For example, the sub-node **4904***a* represents the expression primitive **4326** relating to the brand category and which has a value of "Motrin." The sub-node **4904***b* represents the expression primitive **4326** relating to the strength category and which has a value of "200 MG." The sub-node **4904***c* represents the expression primitive **4326** relating to the dose form category and which has a value of "tablet." The sub-node **4904***d* represents the expression primitive **4326** relating to the route category and which has a value of "oral." In some examples, the primary node **4902** is also associated with a class node **4908**. The class node **4908** may associate other relational graphs that reference anti-inflammatory medications. The class node **4908** may include a class node identifier that is unique to the class node **4908**.

FIG. **50** illustrates an example flow chart showing the process **5000** for searching an electronic health record using a medical term expression, according to at least one

example. The process **5000** may be performed by the user device **104**. The provider subscription system **112** may also perform the process **5000**.

The process **5000** may begin at **5002** by receiving a search query to search a health record. The health record may be associated with a user account. The search query may include at least one search term. In some examples, at least part of the health record may be stored on a user device (e.g., the user device **104**). In some examples, the health record may include a plurality of medical sub-records sourced from one or more gateways of one or more electronic health record systems.

At **5004**, the process **5000** may include processing the search query to generate a medical term expression. The medical term expression may be representative of the search query and may include at least one expression primitive corresponding to the at least one search term. In some examples, the medical term expression may be a medical term index usable for accessing a database in which the at least one expression primitive is stored. In some examples, processing the search query to generate the medical term expression may include indexing the at least one search term using an indexing algorithm.

At **5006**, the process **5000** may include identifying a medical concept corresponding to the medical term expression. In some examples, identifying the medical concept corresponding to the medical term expression may include identifying the medical concept based at least in part on the at least one expression primitive.

At **5008**, the process **5000** may include identifying a plurality of other medical expression primitives corresponding to a plurality of record entries in the health record. In some examples, this may be based at least in part on the at least one expression primitive and the medical concept. The plurality of record entries may be associated with the medical concept. In some examples, identifying the plurality of other medical expression primitives corresponding to the plurality of record entries in the health record may include using the at least one expression primitive as an index to access a database in which information about the health record is stored.

At **5010**, the process **5000** may include providing for presentation at the user device information about the plurality of record entries. In some examples, providing for presentation information about the plurality of record entries may include grouping the information about the plurality of record entries under a heading corresponding to the medical concept.

In some examples, the process **5000** may further include using the medical term expression to generate a uniform medical term corresponding to the at least one search term.

In some examples, the process **5000** may further include associating, in a database stored on the user device, metadata with medical term expressions representing the medical terms from the health record. In this example, the metadata may be descriptive of the medical terms represented by the medical term expressions. In this example, the process **5000** may further include generating an index that associates the medical term expressions with reference identifiers of the medical terms from the electronic health record. In this example, the process **5000** may further include receiving a request for information about a particular medical term found in the electronic health record. In this example, the process **5000** may further include, in response to receiving the request, accessing the database using a particular medical term expression associated with the particular medical term and the index to retrieve the information about the particular medical term. The information about the particular medical term may include certain metadata that is descriptive of the particular medical term. In this example, the process **5000** may further include providing the information about the particular medical term for presentation at the user device. The information about the particular medical term may provide contextual information about the particular medical term that was not originally present in the electronic health record.

FIG. **51** illustrates an example flow chart showing the process **5100** for searching a relational graph representing a medical concept, according to at least one example. The process **5100** may be performed by the user device **104**. The provider subscription system **112** may also perform the process **5100**.

The process **5100** may begin at **5102** by accessing a health record stored according to a first data model. The health record may be stored on a user device associated with a user account. The user account may belong to a user of the user device.

At **5104**, the process **5100** may include, for an entry of the health record, identifying a medical concept present in the entry. This may be performed based at least in part on a medical term expression generated to represent at least a portion of the entry.

At **5106**, the process **5100** may include creating a node in a relational graph representing the medical concept. The relational graph may be unique to the user account. In this manner, each user may include her own personalized relational graph stored on her user device.

At **5108**, the process **5100** may include adding one or more sub-nodes to the node in the relational graph. This may be performed based at least in part on additional information relating to the medical concept. In some examples, adding the one or more sub-nodes to the node in the relational graph may include receiving an additional health record, indexing medical terms found in the additional health record to generate medical term expressions, identifying one or more medical concepts based at least in part on the medical term expressions, and for those medical term expressions having the same medical concept as the medical concept, adding additional sub-nodes to the node.

At **5110**, the process **5100** may include storing the relational graph including the one or more sub-nodes on the user device according to a second data model.

At **5112**, the process **5100** may include responsive to a request, providing information represented by at least one of the one or more sub-nodes for presentation at the user device. In some examples, the request may be at least one of a search request or a filter request. The search request may request searching of the health record. The filter request may request filtering of a portion of the health record.

In some examples, the process **5100** may further include adding additional sub-nodes to the node based at least in part on detecting updates to a global term base. The global term base may be stored by a server computer.

In some examples, the process **5100** may further include adding additional sub-nodes to the node based at least in part on identifying, in a remote database, metadata associated with the medical concept.

FIG. **52** illustrates an example user interface (UI) view **5200** illustrating a portion of an electronic health record organized according to medical concepts, according to at least one example. The UI view **5200**, which may be presented on the user device **104**, is an example of UI views (1)-(25). In particular the UI view **5200** may be presented after the user has downloaded at least one electronic health

record to her device (e.g., one connection with an EHR gateway has been established).

The UI view **5200** includes a plurality of medical concepts **5202***a*-**5202***e* according to which is organized a plurality of medical records entries **5204***a*-**5204***e*. The medical concepts **5202** may be fixed, as described herein. The medical record entries **5204**, which represent medical terms, may be associated with the medical concepts **5202** as part of the indexing process described herein. In particular, these associations between medical terms from the user's electronic health record and the medical concepts may be stored in the user's personalized relational graph in the on-device term base.

The medical record entries **5204** may be sourced from one or more electronic health records, but may be presented in the same UI view **5200**. By default, the medical record entries **5204** may be sorted based on any suitable factor. For example, the medical record entries **5204***a* may be sorted based on whether the condition is "active" or "inactive." Similarly, the medical record entries **5204***d* may be sorted based on date of procedure.

Selection of the "view all >" UI element on any of the medical concepts **5202** may reveal other medical record entries **5204** associated with the relevant medical concept **5202**. For example, selection of the "view all" UI element associated with the medical concept **5202***a* (conditions), may reveal additional medical record entries **5204***a* in addition to the three listed. In some examples, this may provide a more complete picture of the user's health record.

Selection of the ">" UI element following one of the labels (e.g., active, inactive, date, etc.) may reveal additional information about the particular medical record entry **5204**. For example, selection of the medical record entry **5204***b* for "Zestril" may reveal additional information about this prescription. A first portion of the additional information may have been sourced from the medical record (e.g., a prescribing doctor, a pharmacy where it was filled, etc.). A second portion of the additional information may have been added using the techniques described herein. For example, the additional information may include metadata downloaded from the off-device term base that is associated with the prescription Zestril (e.g., images of the pill, ingredients, etc.).

In some examples, the techniques described herein, may be used to associate medical record entries **5204** across different medical categories **5202**. For example, assume that a first medical term identifies the medical record entry **5204***a* for hypertension and a second medical term identifies the medical record entry **5204***b* for Zestril. The relational graph on the device may include an association between a condition of hypertension and a prescription for Zestril. This may be because Zestril is prescribed to treat hypertension. If the medical record from which the condition and prescription were obtained did not already include this association, the techniques described herein may add this association and present information about it. For example, continuing with the example above, selection of "Zestril" may reveal that additional information that indicates that it is being used to treat the condition of hypertension.

FIG. **53** illustrates an example architecture or environment **5300** configured to implement techniques described herein, according to at least one example. In some examples, the example architecture **5300** may further be configured to enable the user device **104**, service provider computers **5302** to share information. The service provider computers **5302** are examples of the business subscription system **206**, the provider subscription system **112**, the EHR systems **114**, and the terminology management system **130**. In some examples, the devices may be connected via one or more networks **5308** (e.g., via Bluetooth, WiFi, the Internet, or the like). In some examples, the service provider computers **5302** may be configured to implement at least some of the techniques described herein with reference to the user device **104**.

In some examples, the networks **5308** may include any one or a combination of many different types of networks, such as cable networks, the Internet, wireless networks, cellular networks, satellite networks, other private and/or public networks, or any combination thereof. While the illustrated example represents the user device **104** accessing the service provider computers **5302** via the networks **5308**, the described techniques may equally apply in instances where the user device **104** interacts with the service provider computers **5302** over a landline phone, via a kiosk, or in any other manner. It is also noted that the described techniques may apply in other client/server arrangements (e.g., set-top boxes, etc.), as well as in non-client/server arrangements (e.g., locally stored applications, peer to peer configurations, etc.).

As noted above, the user device **104** may be any type of computing device such as, but not limited to, a mobile phone, a smartphone, a personal digital assistant (PDA), a laptop computer, a desktop computer, a thin-client device, a tablet computer, a wearable device, or the like. In some examples, the user device **104** may be in communication with the service provider computers **5302** via the network **5308**, or via other network connections.

In one illustrative configuration, the user device **104** may include at least one memory **5314** and one or more processing units (or processor(s)) **5316**. The processor(s) **5316** may be implemented as appropriate in hardware, computer-executable instructions, firmware, or combinations thereof. Computer-executable instruction or firmware implementations of the processor(s) **5316** may include computer-executable or machine-executable instructions written in any suitable programming language to perform the various functions described. The user device **104** may also include geo-location devices (e.g., a global positioning system (GPS) device or the like) for providing and/or recording geographic location information associated with the user device **104**.

The memory **5314** may store program instructions that are loadable and executable on the processor(s) **5316**, as well as data generated during the execution of these programs. Depending on the configuration and type of the user device **104**, the memory **5314** may be volatile (such as random access memory (RAM)) and/or non-volatile (such as read-only memory (ROM), flash memory, etc.). The user device **104** may also include additional removable storage and/or non-removable storage **5326** including, but not limited to, magnetic storage, optical disks, and/or tape storage. The disk drives and their associated non-transitory computer-readable media may provide non-volatile storage of computer-readable instructions, data structures, program modules, and other data for the computing devices. In some implementations, the memory **5314** may include multiple different types of memory, such as static random access memory (SRAM), dynamic random access memory (DRAM), or ROM. While the volatile memory described herein may be referred to as RAM, any volatile memory that would not maintain data stored therein once unplugged from a host and/or power would be appropriate.

The memory **5314** and the additional storage **5326**, both removable and non-removable, are all examples of non-

transitory computer-readable storage media. For example, non-transitory computer readable storage media may include volatile or non-volatile, removable or non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules, or other data. The memory **5314** and the additional storage **5326** are both examples of non-transitory computer storage media. Additional types of computer storage media that may be present in the user device **104** may include, but are not limited to, phase-change RAM (PRAM), SRAM, DRAM, RAM, ROM, Electrically Erasable Programmable Read-Only Memory (EEPROM), flash memory or other memory technology, compact disc read-only memory (CD-ROM), digital video disc (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store the desired information and that can be accessed by the user device **104**. Combinations of any of the above should also be included within the scope of non-transitory computer-readable storage media. Alternatively, computer-readable communication media may include computer-readable instructions, program modules, or other data transmitted within a data signal, such as a carrier wave, or other transmission. However, as used herein, computer-readable storage media does not include computer-readable communication media.

The user device **104** may also contain communications connection(s) **5328** that allow the user device **104** to communicate with a data store, another computing device or server, user terminals, and/or other devices via the network **5308**. The user device **104** may also include I/O device(s) **5330**, such as a keyboard, a mouse, a pen, a voice input device, a touch input device, a display, speakers, a printer, etc.

Turning to the contents of the memory **5314** in more detail, the memory **5314** may include an operating system **5332** and/or one or more application programs or services for implementing the features disclosed herein including the indexing engine **4202**. The service provider computer **5302** may also include a memory **5342** that includes an indexing engine **4202***b*. In this manner, the techniques described herein may be implemented by any one, or a combination of more than one, of the computing devices (e.g., the user device **104** or the service provider computer **5302**).

The service provider computers **5302** may also be any type of computing device such as, but not limited to, a mobile phone, a smartphone, a PDA, a laptop computer, a desktop computer, a thin-client device, a tablet computer, a wearable device, a server computer, a virtual machine instance, etc. In some examples, the service provider computers **5302** may be in communication with the user device **104** via the network **5308**, or via other network connections.

In one illustrative configuration, the service provider computers **5302** may include at least one memory **5342** and one or more processing units (or processor(s)) **5344**. The processor(s) **5344** may be implemented as appropriate in hardware, computer-executable instructions, firmware, or combinations thereof. Computer-executable instruction or firmware implementations of the processor(s) **5344** may include computer-executable or machine-executable instructions written in any suitable programming language to perform the various functions described.

The memory **5342** may store program instructions that are loadable and executable on the processor(s) **5344**, as well as data generated during the execution of these programs. Depending on the configuration and type of service provider computer **5302**, the memory **5342** may be volatile (such as RAM) and/or non-volatile (such as ROM, flash memory, etc.). The service provider computer **5302** may also include additional removable storage and/or non-removable storage **5346** including, but not limited to, magnetic storage, optical disks, and/or tape storage. The disk drives and their associated non-transitory computer-readable media may provide non-volatile storage of computer-readable instructions, data structures, program modules, and other data for the computing devices. In some implementations, the memory **5342** may include multiple different types of memory, such as SRAM, DRAM, or ROM. While the volatile memory described herein may be referred to as RAM, any volatile memory that would not maintain data stored therein once unplugged from a host and/or power would be appropriate. The memory **5342** and the additional storage **5346**, both removable and non-removable, are both additional examples of non-transitory computer-readable storage media.

The service provider computer **5302** may also contain communications connection(s) **5348** that allow the service provider computer **5302** to communicate with a data store, another computing device or server, user terminals and/or other devices via the network **5308**. The service provider computer **5302** may also include I/O device(s) **5350**, such as a keyboard, a mouse, a pen, a voice input device, a touch input device, a display, speakers, a printer, etc.

Turning to the contents of the memory **5342** in more detail, the memory **5342** may include an operating system **5352** and/or one or more application programs or services for implementing the features disclosed herein including the indexing engine **4224***b*.

The various examples further can be implemented in a wide variety of operating environments, which in some cases can include one or more user computers, computing devices or processing devices which can be used to operate any of a number of applications. User or client devices can include any of a number of general purpose personal computers, such as desktop or laptop computers running a standard operating system, as well as cellular, wireless and handheld devices running mobile software and capable of supporting a number of networking and messaging protocols. Such a system also can include a number of workstations running any of a variety of commercially-available operating systems and other known applications for purposes such as development and database management. These devices also can include other electronic devices, such as dummy terminals, thin-clients, gaming systems, and other devices capable of communicating via a network.

Most examples utilize at least one network that would be familiar to those skilled in the art for supporting communications using any of a variety of commercially-available protocols, such as TCP/IP, OSI, FTP, UPnP, NFS, CIFS, and AppleTalk. The network can be, for example, a local area network, a wide-area network, a virtual private network, the Internet, an intranet, an extranet, a public switched telephone network, an infrared network, a wireless network, and any combination thereof.

In examples utilizing a network server, the network server can run any of a variety of server or mid-tier applications, including HTTP servers, FTP servers, CGI servers, data servers, Java servers, and business application servers. The server(s) may also be capable of executing programs or scripts in response to requests from user devices, such as by executing one or more applications that may be implemented as one or more scripts or programs written in any programming language, such as Java®, C, C# or C++, or any scripting language, such as Perl, Python or TCL, as well as

combinations thereof. The server(s) may also include database servers, including without limitation those commercially available from Oracle®, Microsoft®, Sybase®' and IBM®.

The environment can include a variety of data stores and other memory and storage media as discussed above. These can reside in a variety of locations, such as on a storage medium local to (and/or resident in) one or more of the computers or remote from any or all of the computers across the network. In a particular set of examples, the information may reside in a storage-area network (SAN) familiar to those skilled in the art. Similarly, any necessary files for performing the functions attributed to the computers, servers or other network devices may be stored locally and/or remotely, as appropriate. Where a system includes computerized devices, each such device can include hardware elements that may be electrically coupled via a bus, the elements including, for example, at least one central processing unit (CPU), at least one input device (e.g., a mouse, keyboard, controller, touch screen, or keypad), and at least one output device (e.g., a display device, printer, or speaker). Such a system may also include one or more storage devices, such as disk drives, optical storage devices, and solid-state storage devices such as RAM or ROM, as well as removable media devices, memory cards, flash cards, etc.

Such devices also can include a computer-readable storage media reader, a communications device (e.g., a modem, a network card (wireless or wired), an infrared communication device, etc.), and working memory as described above. The computer-readable storage media reader can be connected with, or configured to receive, a non-transitory computer-readable storage medium, representing remote, local, fixed, and/or removable storage devices as well as storage media for temporarily and/or more permanently containing, storing, transmitting, and retrieving computer-readable information. The system and various devices also typically will include a number of software applications, modules, services, or other elements located within at least one working memory device, including an operating system and application programs, such as a client application or browser. It should be appreciated that alternate examples may have numerous variations from that described above. For example, customized hardware might also be used and/or particular elements might be implemented in hardware, software (including portable software, such as applets) or both. Further, connection to other computing devices such as network input/output devices may be employed.

Non-transitory storage media and computer-readable media for containing code, or portions of code, can include any appropriate media known or used in the art, including storage media, such as, but not limited to, volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules, or other data, including RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, DVD or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by a system device. Based at least in part on the disclosure and teachings provided herein, a person of ordinary skill in the art will appreciate other ways and/or methods to implement the various examples.

The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. It will, however, be evident that various modifications and changes may be made thereunto without departing from the broader spirit and scope of the disclosure as set forth in the claims.

Other variations are within the spirit of the present disclosure. Thus, while the disclosed techniques are susceptible to various modifications and alternative constructions, certain illustrated examples thereof are shown in the drawings and have been described above in detail. It should be understood, however, that there is no intention to limit the disclosure to the specific form or forms disclosed, but on the contrary, the intention is to cover all modifications, alternative constructions and equivalents falling within the spirit and scope of the disclosure, as defined in the appended claims.

The use of the terms "a" and "an" and "the" and similar referents in the context of describing the disclosed examples (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (e.g., meaning "including, but not limited to,") unless otherwise noted. The term "connected" is to be construed as partly or wholly contained within, attached to, or joined together, even if there is something intervening. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate examples of the disclosure and does not pose a limitation on the scope of the disclosure unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the disclosure.

Disjunctive language such as the phrase "at least one of X, Y, or Z," unless specifically stated otherwise, is otherwise understood within the context as used in general to present that an item, term, etc., may be either X, Y, or Z, or any combination thereof (e.g., X, Y, and/or Z). Thus, such disjunctive language is not generally intended to, and should not, imply that certain examples require at least one of X, at least one of Y, or at least one of Z to each be present.

Preferred examples of this disclosure are described herein, including the best mode known to the inventors for carrying out the disclosure. Variations of those preferred examples may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the disclosure to be practiced otherwise than as specifically described herein. Accordingly, this disclosure includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the disclosure unless otherwise indicated herein or otherwise clearly contradicted by context.

All references, including publications, patent applications, and patents, cited herein are hereby incorporated by reference to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

As described above, one aspect of the present technology is the gathering and use of data available from various sources to provide a comprehensive and complete window to a user's personal health record. The present disclosure contemplates that in some instances, this gathered data may include personal information data that uniquely identifies or can be used to contact or locate a specific person. Such personal information data can include demographic data, location-based data, telephone numbers, email addresses, twitter ID's, home addresses, data or records relating to a user's health or level of fitness (e.g., vital signs measurements, medication information, exercise information), date of birth, or any other identifying or personal or health information.

The present disclosure recognizes that the use of such personal information data, in the present technology, can be used to the benefit of users. For example, the personal information data can be used to provide enhancements to a user's personal health record. Further, other uses for personal information data that benefit the user are also contemplated by the present disclosure. For instance, health and fitness data may be used to provide insights into a user's general wellness, or may be used as positive feedback to individuals using technology to pursue wellness goals.

The present disclosure contemplates that the entities responsible for the collection, analysis, disclosure, transfer, storage, or other use of such personal information data will comply with well-established privacy policies and/or privacy practices. In particular, such entities should implement and consistently use privacy policies and practices that are generally recognized as meeting or exceeding industry or governmental requirements for maintaining personal information data private and secure. Such policies should be easily accessible by users, and should be updated as the collection and/or use of data changes. Personal information from users should be collected for legitimate and reasonable uses of the entity and not shared or sold outside of those legitimate uses. Further, such collection/sharing should occur after receiving the informed consent of the users. Additionally, such entities should consider taking any needed steps for safeguarding and securing access to such personal information data and ensuring that others with access to the personal information data adhere to their privacy policies and procedures. Further, such entities can subject themselves to evaluation by third parties to certify their adherence to widely accepted privacy policies and practices. In addition, policies and practices should be adapted for the particular types of personal information data being collected and/or accessed and adapted to applicable laws and standards, including jurisdiction-specific considerations. For instance, in the US, collection of or access to certain health data may be governed by federal and/or state laws, such as the Health Insurance Portability and Accountability Act (HIPAA); whereas health data in other countries may be subject to other regulations and policies and should be handled accordingly. Hence different privacy practices should be maintained for different personal data types in each country.

Despite the foregoing, the present disclosure also contemplates embodiments in which users selectively block the use of, or access to, personal information data. That is, the present disclosure contemplates that hardware and/or software elements can be provided to prevent or block access to such personal information data. For example, in the case of advertisement delivery services or other services relating to health record management, the present technology can be configured to allow users to select to "opt in" or "opt out" of participation in the collection of personal information data during registration for services or anytime thereafter. In addition to providing "opt in" and "opt out" options, the present disclosure contemplates providing notifications relating to the access or use of personal information. For instance, a user may be notified upon downloading an app that their personal information data will be accessed and then reminded again just before personal information data is accessed by the app.

Moreover, it is the intent of the present disclosure that personal information data should be managed and handled in a way to minimize risks of unintentional or unauthorized access or use. Risk can be minimized by limiting the collection of data and deleting data once it is no longer needed. In addition, and when applicable, including in certain health related applications, data de-identification can be used to protect a user's privacy. De-identification may be facilitated, when appropriate, by removing specific identifiers (e.g., date of birth, etc.), controlling the amount or specificity of data stored (e.g., collecting location data a city level rather than at an address level), controlling how data is stored (e.g., aggregating data across users), and/or other methods.

Therefore, although the present disclosure broadly covers use of personal information data to implement one or more various disclosed embodiments, the present disclosure also contemplates that the various embodiments can also be implemented without the need for accessing such personal information data. That is, the various embodiments of the present technology are not rendered inoperable due to the lack of all or a portion of such personal information data.

What is claimed is:

1. A computer-implemented method, comprising:

generating a medical entity batch comprising a brand entity set, a location entity set, and a gateway entity set;

assigning a batch identifier to the medical entity batch, individual entities in the medical entity batch being associated with respective entity identifiers;

receiving a search query from a user device, the search query comprising one or more search terms;

providing search results to the user device based at least in part on the one or more search terms, the search results comprising a list of medical entities;

receiving a request from the user device for information about a particular medical entity from the list of medical entities, the particular medical entity belonging to the medical entity batch, and the request comprising the batch identifier and a particular entity identifier identifying the particular medical entity; and

providing, to the user device, the information about the particular medical entity together with other information about other entities in the medical entity batch.

2. The computer-implemented method of claim **1**, wherein the request is a first request, the method further comprising receiving a second request from the user device for additional information about the particular medical entity, the second request comprising the batch identifier and the particular entity identifier.

3. The computer-implemented method of claim **1**, wherein the request is a first request and the batch identifier is a first batch identifier, the method further comprising receiving a second request from a different user device for information about the particular medical entity, the second request comprising a second batch identifier and the particular entity identifier.

4. The computer-implemented method of claim **1**, wherein generating the medical entity batch comprises:

selecting a first location entity associated with a first geographic location;

beginning, based at least in part on the first geographic location, an outward expanding geographic search for other entities; and

ceasing the outward expanding geographic search when a threshold number of entities has been identified for each of the brand entity set, the location entity set, and the gateway entity set.

5. The computer-implemented method of claim **1**, further comprising, after assigning the batch identifier, storing information about the medical entity batch in association with the batch identifier in a provider database configured to store the information about the medical entities in the medical entity batch and other medical entities in other medical entity batches.

6. One or more non-transitory computer-readable media comprising computer-executable instructions that, when executed by one or more processors, cause the one or more processors to perform operations comprising:

providing, to a provider subscription service, a search query comprising one or more search terms;

receiving, from the provider subscription service, search results based at least in part on the one or more search terms, the search results comprising a list of medical entities;

providing, to the provider subscription service, a request for information about a particular medical entity from the list of medical entities, the particular medical entity belonging to an entity batch comprising a plurality of medical entities, and the request comprising a batch identifier assigned to the entity batch and a particular entity identifier identifying the particular medical entity; and

receiving, from the provider subscription service, the information about the particular medical entity together with other information about other medical entities in the entity batch.

7. The one or more non-transitory computer-readable media of claim **6**, wherein the entity batch comprises a brand entity set, a location entity set, and a gateway entity set.

8. The one or more non-transitory computer-readable media of claim **6**, wherein receiving the information about the particular medical entity together with the other information about the other medical entities in the entity batch obfuscates an identity of the particular medical entity.

9. The one or more non-transitory computer-readable media of claim **6**, wherein one or more non-transitory computer-readable media comprise further computer-executable instructions that, when executed by the one or more processors, perform operations comprising establishing a connection with a gateway entity associated with the particular medical entity.

10. The one or more non-transitory computer-readable media of claim **9**, wherein one or more non-transitory computer-readable media comprise further computer-executable instructions that, when executed by the one or more processors, perform operations comprising downloading, via the connection with the gateway entity, health record information.

11. The one or more non-transitory computer-readable media of claim **10**, wherein downloading the health record information comprises downloading the health record information without sharing any portion of the health record information with the provider subscription service.

12. The one or more non-transitory computer-readable media of claim **9**, wherein the information about the particular medical entity comprises configuration information associated with the gateway entity, the configuration information defining one or more predefined method calls for establishing the connection with the gateway entity and downloading data from the gateway entity.

13. The one or more non-transitory computer-readable media of claim **9**, wherein one or more non-transitory computer-readable media comprise further computer-executable instructions that, when executed by the one or more processors, perform operations comprising storing an entity identifier associated the particular medical entity in association with the other entity identifiers associated with the other medical entities at least during a period of time when the connection with the gateway entity exists.

14. A computer-implemented method, comprising:

receiving, from a server and based at least in part on a search query comprising one or more search terms, search results comprising a minimum number of medical entities, the search results selected based at least in part on the one or more search terms, individual medical entities of the minimum number of medical entities being associated with entity identifiers;

receiving user selection of a first medical entity from the minimum number of medical entities;

storing a first entity identifier associated the first medical entity in association with other entity identifiers associated with other medical entities from the minimum number of medical entities; and

receiving, from the server and in based at least in part on a request for information about the first medical entity, the information about the first medical entity together with other information about the other medical entities.

15. The computer-implemented method of claim **14**, wherein the request comprises the first entity identifier and the other entity identifiers.

16. The computer-implemented method of claim **14**, wherein receiving the information about the first medical entity together with the other information about the other medical entities obfuscates, from the server, an identity of the first medical entity as the medical entity that was subject to the user selection.

17. The computer-implemented method of claim **14**, further comprising establishing a connection with a gateway entity associated with the first medical entity.

18. The computer-implemented method of claim **17**, wherein the information about the first medical entity comprises configuration information associated with the gateway entity, the configuration information defining one or more predefined method calls to establish the connection with the gateway entity and download data from the gateway entity.

19. The computer-implemented method of claim **18**, further comprising using the one or more predefined method calls to establish the connection with the gateway entity.

20. The computer-implemented method of claim **17**, wherein storing the first entity identifier associated the first medical entity in association with the other entity identifiers associated with the other medical entities comprises storing at least during a period of time when the connection with the gateway entity exists.

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